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Comparative Evaluation Of Solubility Of Conventional Luting Cements In Commonly Used Mouthrinses At Different Time Intervals

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Abstract:
Context:*Solubility Is An Important Feature In The Assessment Of The Clinical Durability Of Dental Cements And Has Been The Subject Of Numerous Experimental And Clinical Studies*
Aims:*To Evaluate And Compare The Effect Of Commonly Used Mouthwash (Chlorhexidine, Betadine) On The Solubility Of Conventional Luting Cements- Zinc Phosphate And GIC At Different Time Intervals.*
Methods And Material:*Restorative Materials And Solutions Used - Zinc Phosphate Cement (Harvard) And Glass Ionomer Cement (GC Fuji I), Distilled Water (Control), Betadine And Non-Alcohol Based Chlorhexidine Mouthwash. Distilled Water Was Used As A Control To Compare The Difference In Solubility With Mouthwashes At Different Time Interval Maintained At Same Atmospheric Conditions.Specimens Of Each Cement Type Were Separated Into Three Groups (8 Per Group) For Evaluation And Compared At 24 Hour And 7 Days Immersion Period.*
Results:*Data Was Analyzed Using The Statistical Package SPSS 22.0 (SPSS Inc., Chicago, IL) And Level Of Significance Was Set At P<0.05. Inferential Statistics To Find Out The Difference Between The Groups Was Done Using INDEPENDENT T Test Within The Group Was Done Using PAIRED T Test Between Any Two Groups.The Solubility Of GIC Was More Than That Of Zinc Phosphate In All Three Test Solutions After Both 24 Hours And 7 Days And Was Statistically Significant.*
Conclusions:*The Clinical Implication Of This Result Suggests The Use Of Chlorhexidine Mouthwash As Pre-Operative Oral Rinse In Dental Clinics Rather Than Betadine.*
Key-Words:*Solubility, Luting Cements, Mouthwashes*

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I. Introduction:

Permanent cementing and the selection of cement are extremely important factors for the long-term success of fixed prosthodontics therapy. Success also depends on the type of restoration, the clinical circumstances and the characteristics of the cement material. Although achieving the optimal retentive and resistant form of the prepared tooth is of primary importance, the role of dental cement is not negligible[1,2].

Good dental cement must be resistant to disintegration and dissolution where a thin layer of cement may possibly be completely dissolved, creating a space susceptible to plaque accumulation and secondary caries, which, if not observed in time, leads to tooth decay, infraction of the margin of restoration, and debonding of the restoration[3-6].

Solubility is therefore an important feature in the assessment of the clinical durability of dental cements and has been the subject of numerous experimental and clinical studies[7-10].

Nowadays mouthwashes are widely used even without a dental prescription. According to a study by Moran JM et al, frequency of using mouthwashes was up to six times per day[11]. Water, antimicrobial agents, salts, preservatives, and alcohol are the different constituents of mouthrinses[12].

A. Vergara-Buenaventura et al in their recent article have recommended preoperative antimicrobial mouth rinses with chlorhexidine gluconate (CHX), cetylpyridinium chloride (CPC), povidone-iodine (PVP-I), and hydrogen peroxide (H_2O_2) to reduce the number of microorganismsin aerosols and drops during oral procedures[13].

There is no study till date to compare the effect of mouthwashes on the solubility of conventional luting cements. Hence, the aim of this study was to evaluate and compare the effect of commonly used mouthwash (chlorhexidine, betadine) on the solubility of conventional luting cements- Zinc phosphate and GIC at different time intervals.

II. Material and Methods:

Restorative materials and solutions used in this study were- Zinc phosphate cement (Harvard) and Glass Ionomer cement (GC Fuji I), distilled water (control), betadine and non-alcohol based chlorhexidine mouthwash as shown in figure 1. Ethical clearance was not obtained as the study was in-vitro and did not involved any living participants.

The pH of mouthwashes was measured using pH meter Orion Star A2TT and was recorded. The pH of betadine mouthwash was found to be acidic approximately 5.68 whereas the pH of chlorhexidine mouthwash was basic around 7.59 and near neutral zone.

To conduct the study a standard stainless-steel mold (figure 2.a) was fabricated with two rings of diameter 10 mm and thickness of 2 mm according to ISO standard-4049 to get uniform size for all the specimens required for the study. A total 48 samples of luting agent were made from 24 samples per cement type (figure 2.b and c).

Cements were mixed according to the manufacturer's instructions and placed in the mold and pressed between two flat glass slab under hand pressure to remove excess of materials. Once the cements were set according to manufacturer's instructions they were removed and after removal they were placed in incubator at 37°C ± 1 for 1 hour. Later they were first stored in a desiccator with blue silica gel for 24 hours(hrs). They were weighed on a digital weighing machine to an accuracy of 0.1mg in a digital analytic balance and the 24 hour dessication cycle process was repeated until a constant mass was achieved.

Specimens of each cement type were separated into three groups (8 per group) for evaluation and comparison in distilled water, betadine and chlorhexidine at 24 hour and 7 days immersion period.

Experimental procedure-

Dental cement specimens were reweighed and submerged individually in three study group solutions by pouring 5ml of distilled water, betadine and chlorhexidine separately in glass test tubes for each specimenThe samples were then stored at 37 ± 1°C in incubator. The samples were tested for dissolution by comparing initial weight and final weight at time intervals of 24 hours and 7 days.

At the end of each time period, specimens were removed from the study sample and with clean absorbent paper excess liquid was soaked, and stored in a desiccators containing blue silica gel until samples were totally dry. Amount of weight loss was calculated as the difference between the initial weight of the specimen and its final constant weight after storage in the desiccators. The specimens were then again placed in the desiccators to avoid contamination by air moisture and then stored in an incubator maintained at 37°C ± 1.

Solubility evaluation-

The specimens were subjected for evaluation of solubility by measuring the weight loss. Amount of weight loss was calculated as the difference between initial weight of specimen before placing in the study solutions and its final weight after its storage in the desiccator. Percentage of solubility was calculated.

Weight loss= Initial Weight-Final weight

Percentage of solubility= weight loss×100 ÷ initial weight

Data thus collected was put to statistical analysis.

III. Results:

Comparison ofData was analyzed using the statistical package **SPSS 22.0** (SPSS Inc., Chicago, IL) and level of significance was set at **p<0.05**. **Descriptive statistics** was performed to assess the mean and standard deviation of the respective groups. Normality of the data was assessed using **Shapiro Wilkinson test**. **Inferential statistics** to find out the difference between the groups was done using **INDEPENDENT T test** within the group was done using **PAIRED T test** to find out the difference between any two groups.

MATERIAL	ZINC PHOSPHATE	GIC	P VALUE (INDEPENDENT T TEST)
24 HRS	0.015±0.007	0.04±0.01	0.0001*
7 DAYS	0.02±0.011	0.06±0.02	0.0001*
P VALUE (PAIRED T TEST)	0.26	0.024*	
DIFFERENCE	0.005±0.004	0.02 ±0.01	

Table-1solubility of Zinc Phosphate Vs GIC in distilled water (*P<0.05 is statistically significant)

TABLE 1 explains the solubility comparison at different time intervals with respect to ZINC PHOSPHATE and GIC in water. Paired t test analysis showed significant difference between the time intervals

($p<0.05$) with respect to GIC only. Between groups analysis using INDEPENDENT T TEST shows significant difference in solubility both at 24 hrs and 7 days.($P<0.05$).

MATERIAL	ZINC PHOSPHATE	GIC	P VALUE (INDEPENDENT T TEST)
24 HRS	0.021±0.01	0.05±0.01	0.0001*
7 DAYS	0.025±0.01	0.06±0.01	0.0001*
P VALUE (PAIRED T TEST)	0.43	0.06	
DIFFERENCE	0.04 ±0.0	0.01±0.0	

Table-2solubility of Zinc Phosphate Vs GIC in Betadine (*P<0.05 is statistically significant)

TABLE 2explains the solubility comparison at different time intervals with respect to ZINC PHOSPHATE and GIC in BETADINE. Paired t test analysis did not show any significant difference between the time intervals ($p>0.05$). Between groups analysis using INDEPENDENT T TEST shows significant difference in solubility both at 24 hrs and 7 days. ($P<0.05$).

MATERIAL	ZINC PHOSPHATE	GIC	P VALUE (INDEPENDENT T TEST)
24 HRS	0.008±0.005	0.055±0.007	0.0001*
7 DAYS	0.01±0.006	0.06±0.021	0.0001*
P VALUE (PAIRED T TEST)	0.48	0.53	
DIFFERENCE	0.002 ±0.001	0.005 ± 0.014	

Table-3solubility of Zinc Phosphate Vs GIC in chlorhexidine (*P<0.05 is statistically significant)

TABLE 3 explains the solubility comparison at different time intervals with respect to ZINC PHOSPHATE and GIC in chlorhexidine. Paired t test analysis did not show any significant difference between the time intervals ($p>0.05$). Between groups analysis using INDEPENDENT T TEST shows significant difference in solubility both at 24 hrs and 7 days. ($P<0.05$).

Solubility of zinc phosphate and GIC in distilled water, betadine and chlorhexidine showed that the solubility of GIC was more than that of zinc phosphate in all three test solutions after both 24 hours and 7 days and was statistically significant with maximum solubility values after 7 days.

Comparison of zinc phosphate within group in test solutions did not differ significantly after 24 hours and 7 days with maximum solubility observed in betadine and minimum in chlorhexidine.

Comparison of solubility of GIC within group in test solutions differ significantly between 24 hours and 7 days only in distilled water group with maximum solubility observed in chlorhexidine and minimum in distilled water.

IV. Discussion:

For a luting cement, its clinical performance and durability hinge on many determinants — amongst which are the dimensional stability and structural integrity of the cement in the oral environment. Dimensional change and structural integrity, on the other hand, are a function of the water sorption and solubility properties. For this reason, the water sorption and solubility behaviour of luting cements has been extensively evaluated in clinical trials and in the laboratory. It should be reiterated that clinically, solubility and sorption may cause stress induced degradation of the luting cement. The latter then leads to debonding and/or fracture of the restoration, increased marginal leakage, and increased potential for secondary caries[14,15].

Two important phenomena that can affect the durability of restorations are water sorption and solubility. Water sorption can increase the volume of the material and thereby can act as a plasticizer resulting in the deterioration of the matrix structure[10]. Solubility is defined as the extent to which a material dissolves in a solvent within a given temperature[11].

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[16].

In the present study, the glass ionomer cement showed higher solubility in distilled water, betadine and chlorhexidine mouth rinse in comparison to zinc phosphate cement irrespective of the immersion time and was significant ($p\leq0.05$).

However, within group the difference in solubility was not significant for both GIC and Zinc phosphate in betadine and chlorhexidine mouth rinse at 24 hours and 7 days ($p \geq 0.05$). But the difference in solubility after 7 days was significant for GIC in distilled water.

For Zinc phosphate luting cement solubility was highest in betadine followed by distilled water and then chlorhexidine (minimum solubility). For GIC solubility was highest in betadine followed by chlorhexidine and least in distilled water. The higher solubility observed with betadine mouth rinse may be due the low pH of the solution.

Solubility of zinc phosphate has been shown to be greater than GIC in artificial saliva in studies[9,17], however in this study we used mouth rinses without alcohol which has shown that the solubility of GIC is greater than zinc phosphate. Clinical success with GIC depends on early protection from hydration and dehydration. It is weakened by early exposure to moisture and while desiccation on the other hand produces shrinkage cracks in recently set cement.

Filiz KEYF et al in 2007 compared the water sorption and solubility of four provisional, three permanent luting cements and five restorative cements and found that zinc phosphate and zinc polycarboxylate cements were the most stable materials for solubility and sorption[18].

Abdul Wahab et al in 2010 evaluated and compared water solubility values of luting resin cement with other three conventional luting cements and concluded that resin cement had the highest resistance to solubility followed by polycarboxylate, zinc phosphate and glass ionomer which exhibited the least resistance to solubility[19].

Reshma Karkera et in 2016 also found that the solubility of GIC was higher as compared to zinc phosphate in water[42]. Shak Mehta et al in 2020 compared the solubility of luting cements in artificial saliva of different pH values at different time intervals and found that the solubility was affected by variation in pH where low pH was found to be consistent with increased solubility[17].

The results of other studies may differ, the rate of dissolution of GIC and zinc phosphate cements may change with the liquid powder ratio used and the manufacturer. The data of the present study reflect the solubility of only the particular batches of the product used. similar type of cement from different manufacturer may give different results. One more factor that cause variation from previous studies might be due to differences in specimen size, since difference in size will affect time taken for solvent to completely infiltrate within the resin matrix[20].

V. Conclusion-

The Solubilty of zinc phosphate was less as compared to GIC in tested mouthwashes irrespective of time interval and the solubility was least with chlorhexidine mouthwash. The clinical implication of this result suggests the use of chlorhexidine mouthwash as pre-operative oral rinse in dental clinics rather than betadine.

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FIGURES AND LEGENDS-

Figure 1- A-zinc phosphate cement, B- Glass ionomer cement, C- mouthwashes

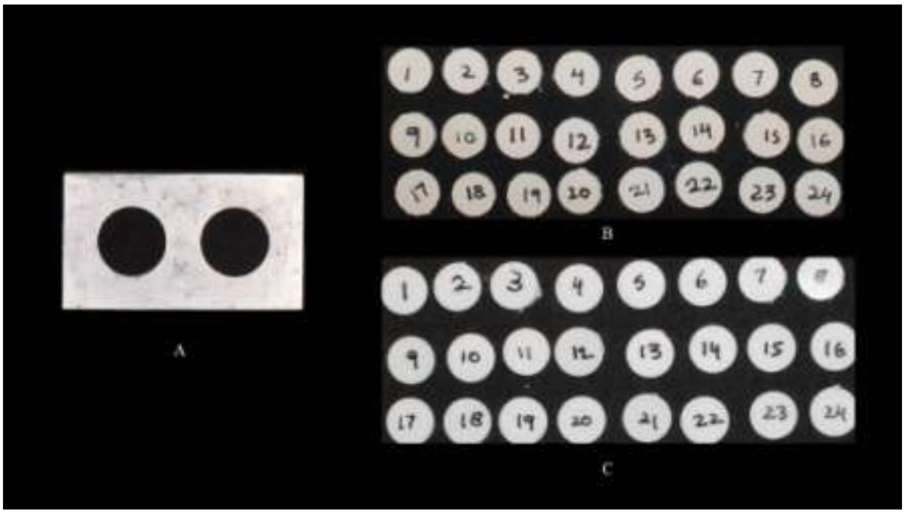

Figure 2- A- Stainless steel mold, B- zinc phosphate samples, C- Glass ionomer samples