ORIGINAL ARTICLE

# Effect of Storage Media on the Solubility of Commercially Available Calcium Hydroxide Cements. A Clear Guideline for Dentists

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**ABSTRACT**

**Objective:** The objective of this study was to evaluate the influence of storage media on the solubility of four different commercially available calcium hydroxide cements.

**Study Design:** Comparative Experimental study

**Place and Duration of Study:** The study was conducted 1st August 2016 to 29th November 2016 at Army Medical College NUMS.

**Materials and Methods:** The present study included four different commercially available calcium hydroxide cements. For each material 8 disc-shaped specimens were prepared according to manufacturer's instructions. Then each material was further divided in to two groups on the basis of storage media. “Group A” used distilled water (DW) and Group B used saliva for the storage of specimens (n=4).Solubility was noted using analytical balance after immersion. Data was analyzed with analysis of variance (ANOVA) and post hock Tukey's test using SPSS 21.

**Results:** A significant difference ($p \leqslant 0.05$) between the results of solubility due to change in media of group A and B was observed. The difference in solubility between the various cements was significant.

**Conclusion:** The study confirmed the difference between the cements on the basis of solubility hence it highlighted the importance of solubility and provides a guideline for the clinician to choose the type of calcium hydroxide that is required in a particular situation on the basis of determined solubility.

**Key Words:** *Calcium Hydroxide, Dental Cavity Lining, Dental Cements Solubility.*

## Introduction

The role of calcium hydroxide in the materials used as bases and cavity liners was identified in the early twentieth century.[1] They are used for pulp protection after injury caused either due to carious lesion or clinical intervention. Also it prevents infiltration of dentinal fluid into the restoration or leaching of restorative components into the oral tissue.[2] Furthermore the ability of calcium hydroxide based cements to simulate dentin recovery has seen an expansion of their use as deep cavity cements.[3-5]

Although, the use of calcium hydroxide cements to induce dentin bridges formation is well documented, their seals are known to be vulnerable to bacterial infections beyond short-term applications. Infection and necrosis are quite common in breached seals (micro-leakages in caps and tunnel defects in dentin bridges), within the first few years of application.[6,7] This is mostly due to lower strength and higher solubility than alternative products.[8] Available literature suggests that base/liner materials become unstable under restorations, possibly due to dissolution after exposure to dentinal fluid or other aqueous media. This results in loss of cavity protection and physical support to restorations.[9,10] Evidence suggests that the solubility and water sorption properties have a direct impact on how well lining between teeth and their restorations endure. Consequently, in the study of the quality of calcium hydroxide cements, their resistance to disintegration is one of the most critical criterion.[11]

Recent developments have seen an advent in the use of resin based calcium containing cements and methylcellulose based cements that have proven to have more resistant, robust and easier to cure compared to their non-resin based counterparts and water based respectively.[12-14] although, the results of pulp capping based on such cements seems to be encouraging, available evidence does not yet suggest that they would act as more resistant

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barriers.[14] Consequently, there is an opportunity to conduct qualitative research to test resin based calcium cements. This study aimed to fill this gap in existing research by presenting a study in the observed performance of various commercially available resin based calcium cements. Of special interest is the observation of their water solubility. The tests conducted focused on all possible factors that breach the cement integrity and their corresponding causes, over a period of time.

Considering the extensive use of calcium hydroxide in the field of dentistry and the varieties of formulation available by different companies with several claims, there was a need for a comprehensive comparison of the materials, particularly in the varying solubility media.

The objective of this study was to evaluate the influence of storage media that is distilled water and saliva on the solubility of four different commercially available calcium hydroxide cements.

## Materials and Methods

The materials used in the experimental in vitro study conducted from 1st August to 30th November 2016 at Army Medical College NUMS were four commercially available calcium hydroxide cements: one chemically cured two paste system Septocalcine ultra +, two with physical mode of activation system (Calcipulp by Septodont and cavity liner paste by Produits Dentaires ) and one resin-based light curing system Cavity Liner, (Light cure Calcium hydroxide paste by Produits Dentaires). Details are given in the table I below:

The ISO 6876 specification was implemented with minor changes to develop the methodology used in this study. For the solubility tests a total of 32 disc-shaped specimens (6.2 mm diameter x 1 mm thick) were prepared according to manufacturer's instructions using a split mould of stainless steel (8 from each material given in figure 1). Then each material was randomly divided by tossing a coin method in to two groups on the basis of different media for immersion. “Group A” used distilled water (DW) and Group B used saliva for the storage of Specimens (n=4).

The percentage difference in mass of the specimens before and after immersion in DW and saliva was determined. Solubility was noted after 24 hours. The methodology has also been illustrated in figure 2.Data was analyzed with analysis of variance (ANOVA) and post hock Tukey's test using SPSS 21.

**TableI: Materials used in the study along with composition and activation modes**

| SR No | Cement | Composition | Activation mode | Batch | Manufacturer |
|---|---|---|---|---|---|
| 1 | Septocalcine ultra +<br><br>(2 paste) | 2 paste<br>Paste A: butyleneglycol salicylate, zinc oxide, calcium phosphate, excipients.<br>Paste B: Calcium Hydroxide, Zinc oxide, excipients | Chemical | 106860571000 | Septodont, France |
| 2 | Calcipulpe Paste (Calcipulpe) | Calcium hydroxide (20.0 %), barium sulphate, excipients | Physical | B14554AB | Septodont, France |
| 3 | Cavity Liner, Paste Calcium hydroxide paste (cavity liner) | Calcium hydroxide, Barium sulfate in a Methylcellulose base | Physical | 8383 AG | Produits Dentaires SA, Switzerland |
| 4 | Cavity Liner, Light cure Calcium hydroxide paste (light cure) | Urethane dimethacrylate, Calcium hydroxide, Barium sulfate, silicates, excipients | Light cure | 8672 DH | Produits Dentaires SA, Switzerland |

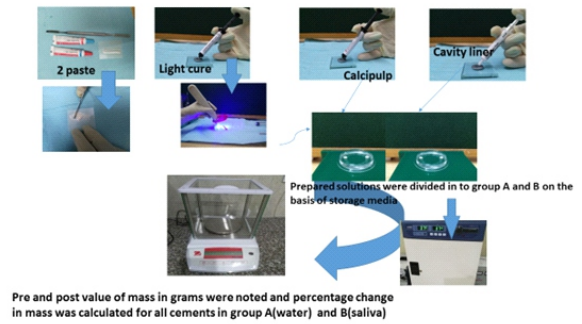


**Fig 1: Methodology used for testing solubility of calcium hydroxide based cements**

## Results

The results of solubility of group A and B and comparison between the groups are given in figure 2 and 3 respectively. There was a significant difference between the results of solubility due to change in storage media of group A and B ($P < 0.01$) while the difference in solubility between the various cements was also significant ($P < 0.05$).

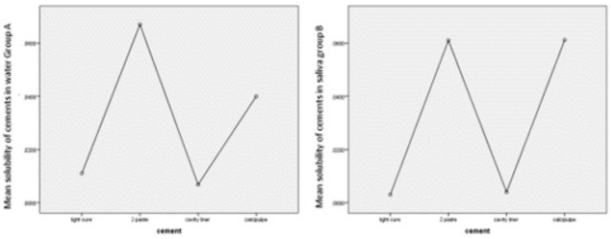

**Fig 2: Means plot showing the effect of storage media on the solubility of various calcium hydroxide cements**

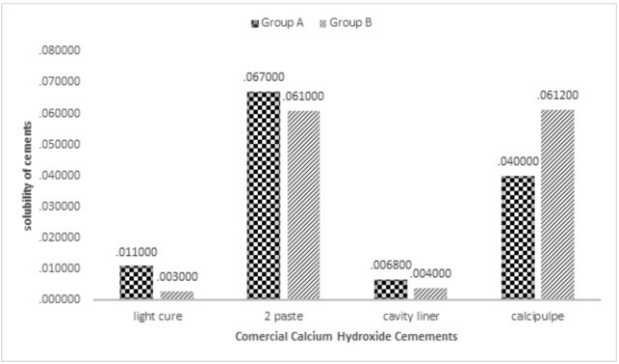


**Fig 3: The effect of environment on the setting time of various calcium hydroxide cements**

## Discussion

The subject of liners and bases has been controversial as there is no single guideline for clinicians, regarding the use of liners and bases. Lot of research work has been done on the biological and mechanical properties of these materials.[15-17] Strength and low solubility are critical features of base and lining materials.[13] The strength and resistance to oral solvents are necessary for the reliable support of restorations, especially the vertical stresses they have to face. Further studies were needed to compensate the gap in current research with regards to loss of strength in bases and loss of hardness in liners, due to solubility of cements and the pH levels of the saliva.

To maintain their protective effects, lining and base materials have to be resistant to dissolution in organic oral solvents.[18] The focus of this study is to identify vital quality indicators for the clinical validity of each tested material. Hence, ISO 6876 specification was used to test the solubility of various cements, not only in distil water but also in saliva. The results of present study were consistent with previous study which concluded that calcium hydroxide cement bases are significantly more soluble in distilled water than in saliva,[19] with exception of calcipulpe. This may be attributed to the excipients present in the cement.

The manufacturers claim physical reliance and longevity due to low solubility. Despite the several variations in their compositions, for all intents and purposes, pulp-capping materials are a mixture of calcium hydroxide and an ester of salicylic acid.[20] A selection of these compositions were evaluated and analysed for this study:

(i) Septocalcine ultra+ (Chemically cured two-paste system)
(ii) Light Cure Calcium Hydroxide paste by Produits Dentaires (resin-based light curing)
(iii) Calcipulp by Septodont (physical mode of activation)
(iv) Cavity Liner Paste by Produits Dentaires(physical mode of activation)

Amongst the cements, light cure calcium hydroxide paste and cavity liner paste performed substantially better than the other two. The low solubility of the light cured system may be attributed to the presence of resin particles in its composition. On comparing the cements with the physical mode of activation, the single paste methyl cellulose based cement showed more resistance to solubility than water based system (figure 2). These observations about the resilience of resin-based lining materials in this study have been validated by Burke and Watts,[21,22] who demonstrated the higher resistance of resin-based lining materials compared to conventional

calcium hydroxide cements. The observation of the increase in resistance to solubility due to presence of methylcellulose has also been previously observed in other cements.[23]

It would be pertinent to emphasise that the results of this study are strictly limited to the parameters and factors described and cannot be extended to other conditions without explicit tests. The need for high strength and low solubility in base materials has been established in this study. However, the solubility should not be low to an extent to hinder the ion exchange with the odontoblastic layer at the dentin-base interface.

## Conclusion

The present study characterized various calcium hydroxide cements on the basis of solubility. These results will be used as a guideline for the clinician to choose the type of calcium hydroxide that is required in a particular situation on the basis of determined solubility.

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