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ORIGINAL ARTICLE

THE INFLUENCE OF MOISTURE ON THE SETTING TIME OF THE LATEST COMMERCIALLY AVAILABLE CALCIUM HYDROXIDE CEMENTS; A CLEAR GUIDELINE FOR THE DENTIST

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Abstract

Calcium hydroxide is a material of choice for pulp capping procedure and is widely used for lining, apexification and root canal dressing. The objective of this study was to evaluate the influence of humidity and temperature on the setting time of four different commercially available calcium hydroxide cements. For each material 10 samples were prepared according to manufacturer's instructions. Then each material was further divided in to two groups using two different ISO standards. In group A, specimens were allowed to set at 37°C and ≤ 90% relative humidity, in a water bath to mimic humidity and temperature conditions of oral cavity without the use of rubber dams. In group B, specimens were tested at 25°C and 50%-57% relative humidity to simulate the effect of rubber dams. All the samples were tested for setting time by Gilmore needle. Setting times were noted when the indenters failed to make a circular indentation on the surface of cement. Data was analyzed with one-way analysis of variance (ANOVA) and post hock Tukey's test using SPSS 21. The results showed a significant difference ($p < 0.05$) between group A and B, showing that the setting of the calcium hydroxide cement is delayed by increase in moisture and temperature. Thus it highlights the importance of using rubber dam in clinical practice. Moreover, the results of the study provides a guideline for the clinician to choose the type of calcium hydroxide needed in a particular situation based on determined setting times.

Key Words: *Calcium Hydroxide, Setting time, Rubber Dam, Dental Cements, Dental Cavity Lining.*

INTRODUCTION

Dental cements are one of the most commonly used dental material, discovered decades ago in the field of dentistry. Since then, considerable efforts has been made to improve their physical and biological properties. Dental cements are used to improve the retention of the restoration,[1] and act as a physical and thermal barrier for the protection of pulp dentine complex.[2]

Since, there are many type of dental cements available, it is challenging for a dental clinician to choose the most suitable cement for the desired procedure. Dental cements are classified into two main groups; temporary cements including calcium hydro-oxide and zinc oxide-eugenol cement and permanent cements including zinc phosphate, zinc poly-carboxylate, conventional glass-ionomer cement, resin-modified glass-ionomer cement and resin cement.[1]

Temporary cements are placed beneath temporary restorations in the interval between preparation and delivery of the final restorations. This time period can vary from several weeks to several months, depending on the clinical situation presents at the time of preparation.[3] Some of the clinical requirements of temporary cements include ease of handling, optimum setting time, good marginal seal to prevent microleakage and recurrent decay. In addition, these cements must have a low "wash out" rate with ease of cleansibility.[3,4] Of these properties, handling and setting time of dental cements is of utmost importance.[5]

Setting time varies with the specific application of dental cements. For luting and lining cements, long working time and short setting time is required while for root canal sealers longer working and setting time is desirable.[6] Short setting time reduces the risk of material contamination and allow placement of the re-

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storative material safely in single visit. The fast setting materials have initially high strength, low solubility and decreased chance of being washed-out.[3,5]

Setting characteristics of dental cements are commonly analyzed by indentation tests via a Gilmore needle.[7] The various factors that influence the setting time of dental cements are the mixing technique, powder/liquid ratio and material composition. The environmental conditions may be altered by the use of rubber dam is also clinically relevant. Calcium hydroxide cement, introduced in 1921 is considered as a "gold standard" pulp capping agent due to its excellent antibacterial property with the ability to stimulate tertiary dentin formation.[8] Apart from this, it is extensively used for lining, apexification, apexogenesis and as a root canal dressing.[9,10]

Considering the extensive use of calcium hydroxide in the field of dentistry and varieties of the formulations available by different companies having several claims, there is a need for a comprehensive comparison of the material particularly in varying the temperature and humidity. The objectives of the present study were to investigate the effect of humidity and temperature on the setting time of different commercially available calcium hydro-oxide cements and to determine the difference between the setting times of different calcium hydroxide based cements. The null hypothesis was that there was no decrease in setting time of cements by using environment that simulates the use of rubber dam.

METHODOLOGY

Various calcium hydroxide cements used in the study are given in Table 1.

Setting time measurements

For each material 10 samples (6x1.2mm) were prepared according to manufacturer's instructions using preformed stainless steel molds. Then each material was further divided in to two groups using two different ISO standards (where n=5 per cement for both groups). "Group A" used the ISO 9917 powder/liquid acid base dental cements intended for lining, restoration and cementation. "Group B" used the ISO 6876 for endodontic sealing materials.

In group A, specimens were allowed to set at 37°C and ≤ 90% relative humidity, in a water bath (Anjue, AJ-HHS4, China). This mimics the moisture and temperature conditions in oral cavity under normal conditions without the use of rubber dams. In group B, specimens were set at 25°C and 50-57% relative humidity in a Isotherm Forced Convection Oven (OFA-54-8) simulating the effect of rubber dam.

All the samples were finally tested by Gilmore (ASTM: C-266-04 / AASHTO: T-154-06) needle with the following two settings: The Initial settings being 100±0.5 gm weight, 2±0/1 mm diameter and the final settings being 400±0.5 gm weight, 1±0.1 mm diameter. Setting times were noted when the indenters failed to make a circular indentation on the surface of cement. The readings were confirmed by testing at two additional positions in test samples. The methodology has also been illustrated in Fig 1. Data were analyzed using one-way analysis of variance (ANOVA) and post hock Tukey's test using SPSS 21.

RESULTS

The initial and final setting times of group A and B are shown in Fig 2 and 3 respectively. The comparison between the groups is shown in Fig 4. There was

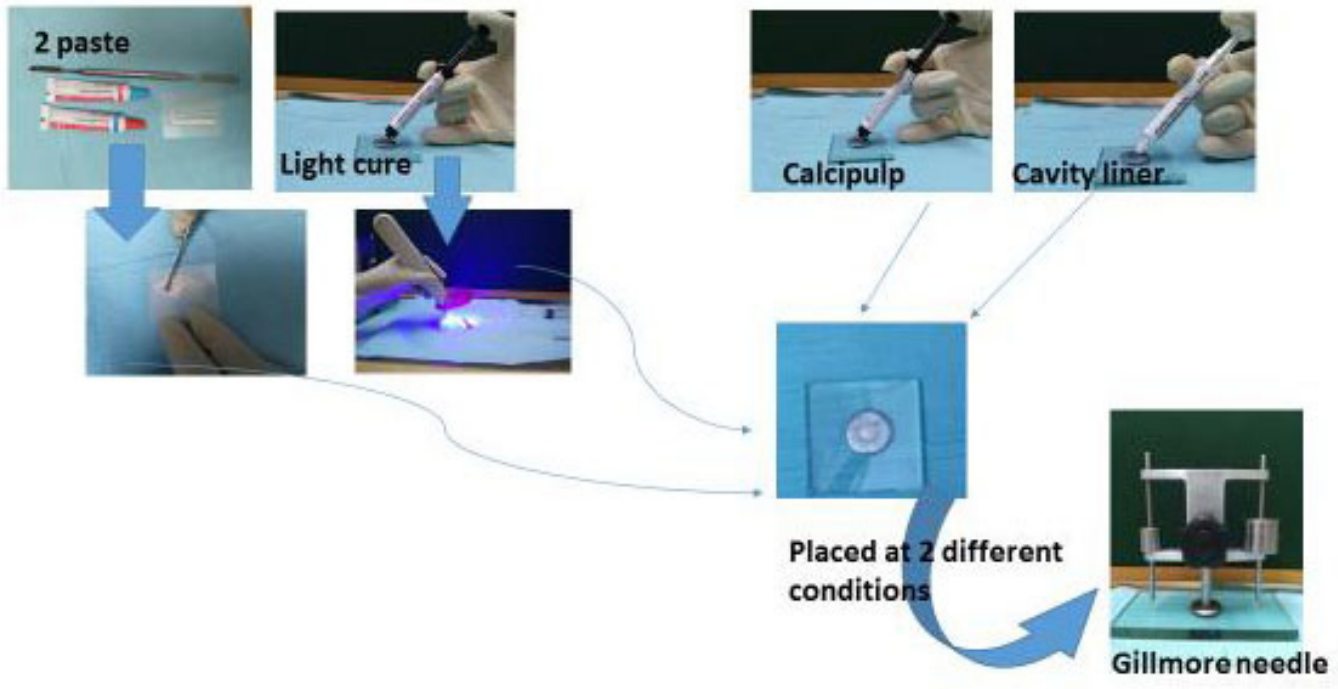

Fig 1: Methodology used for testing time of calcium hydroxide based cements

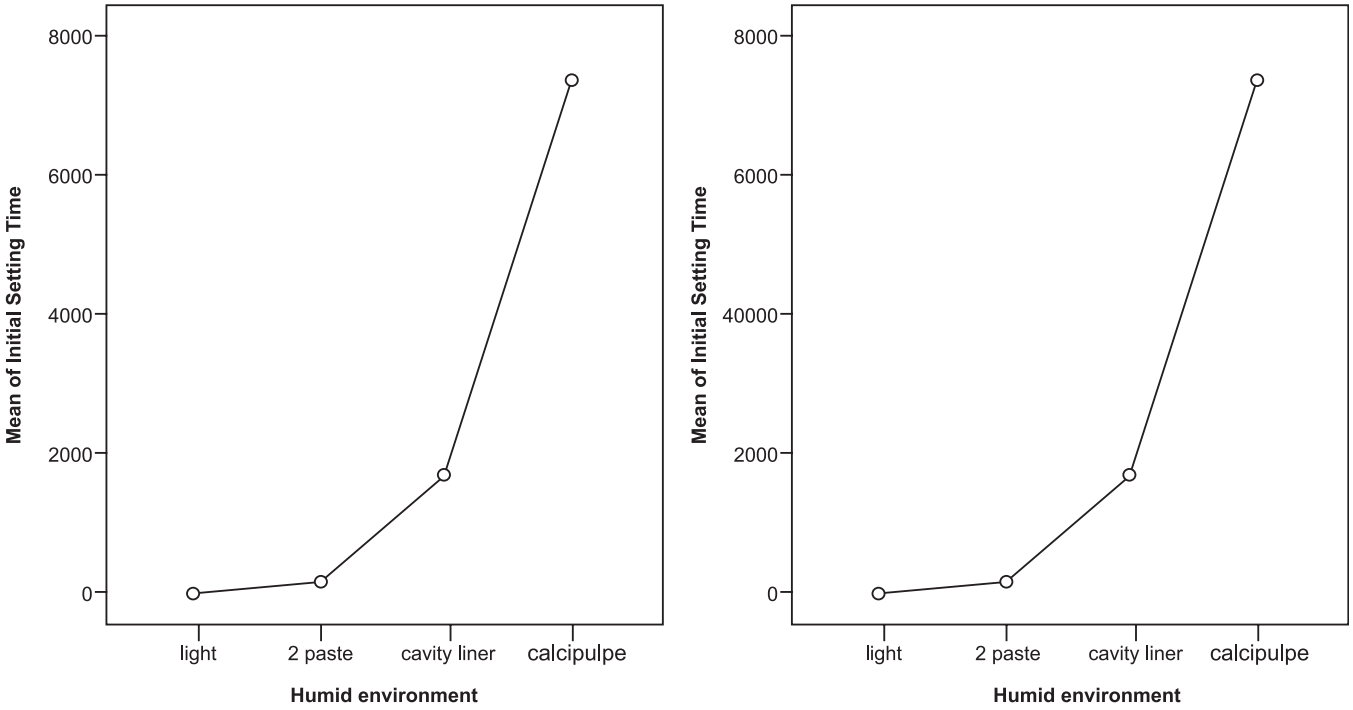

Fig 2: Group A. Initial and final setting time of calcium hydroxide based cements at condition simulating oral cavity

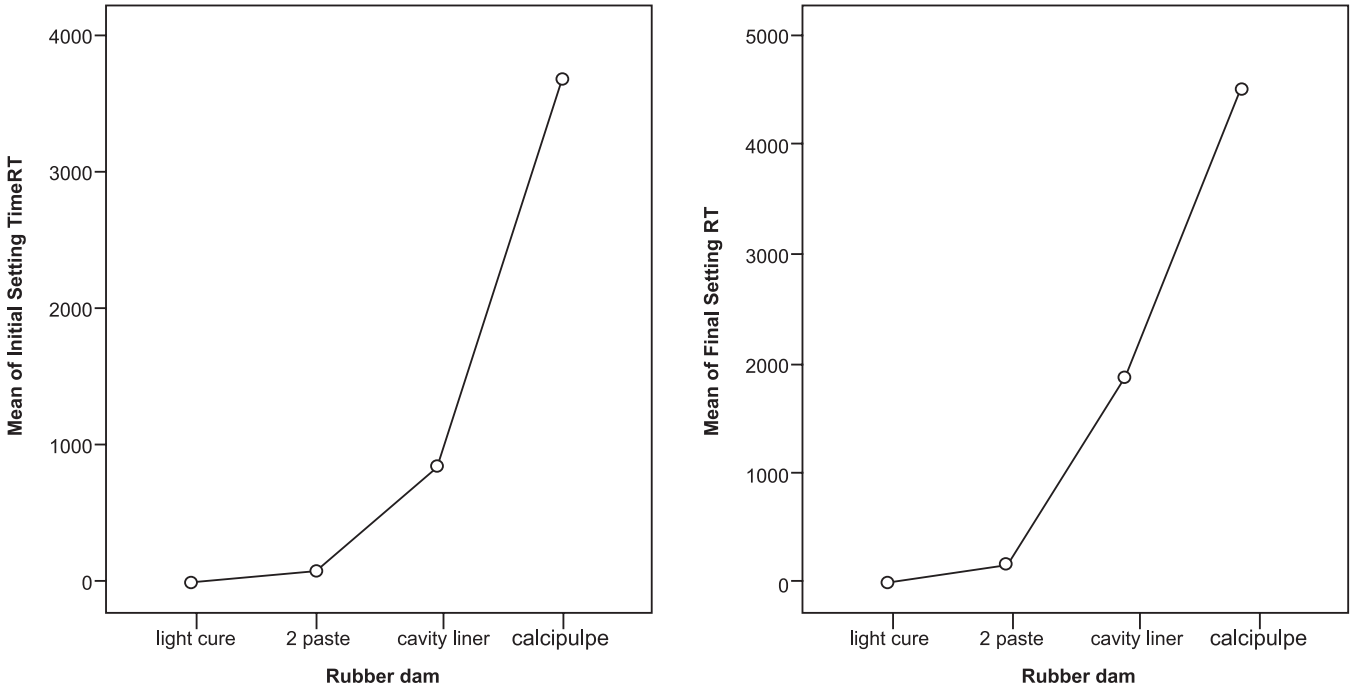

Fig 3: Group A. Initial and final setting time of calcium hydroxide based cements at condition simulating rubber dam

a significant difference between the results of setting time due to change in environment of group A and B ($P < 0.05$) while the difference in setting time between the various cements was significant except for light cure($P=0.271$)and two paste calcium hydroxide cements ($P=0.271$). Hence the null hypothesis was rejected.

DISCUSSION

Calcium hydroxide cement is a material of choice for pulp capping procedure and is also widely used for deep cavity lining, apexification and root canal dressing.[2,11] The subject of liner and base has been controversial as there is no single guideline for the clinicians, regarding

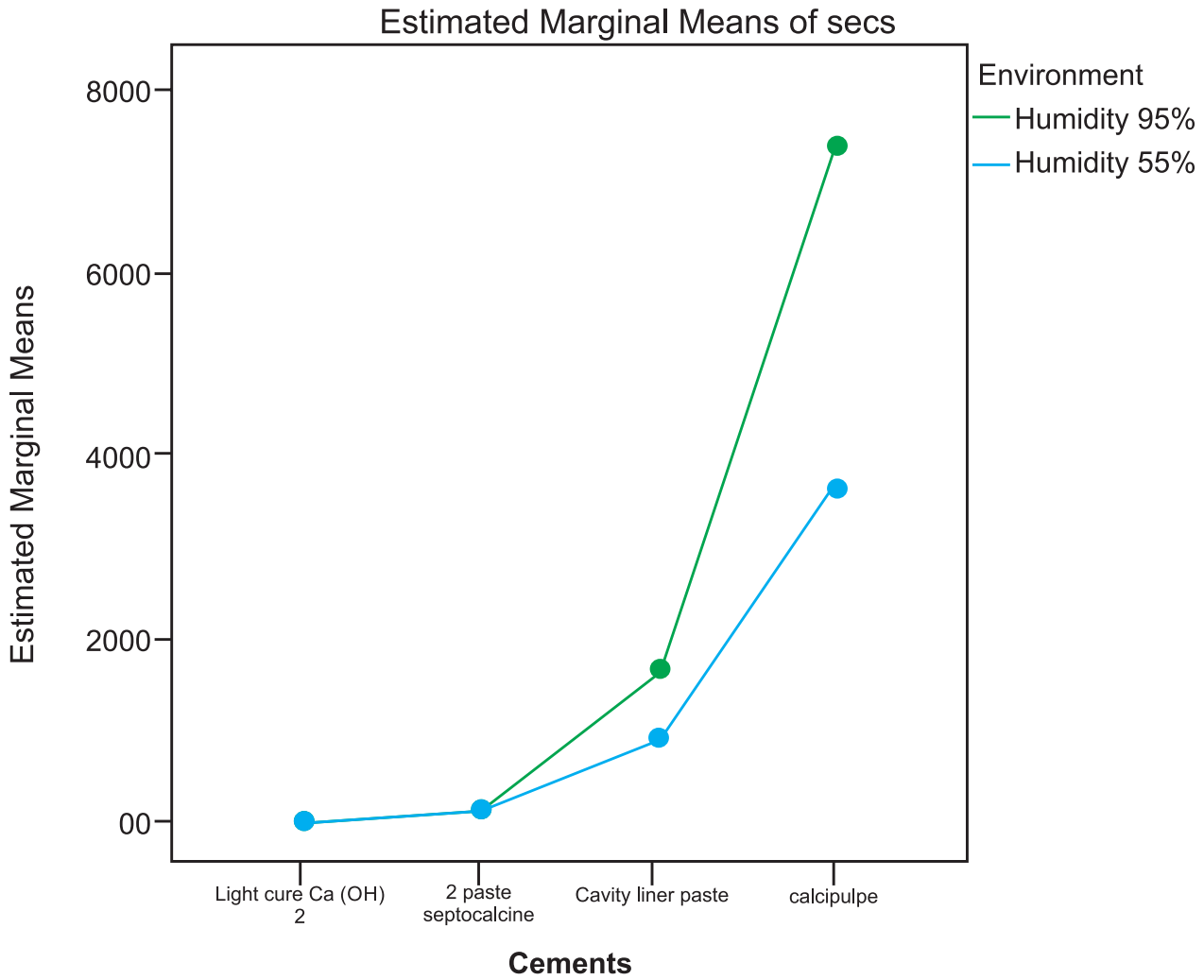

Fig 4: Means plot showing the effect of environment on the setting time of various calcium hydroxide cements. Group A is shown by blue line while group B is shown by Green Line

TABLE 1: MATERIALS USED IN THE STUDY ALONG WITH COMPOSITION AND ACTIVATION MODES

S. No.	Cement	Composition	Activation mode	Batch	Manufacturer
1	Septocalcine ultra + (2 paste)	2 paste Paste A: butyleneglycol salicylate, zinc oxide, calcium phosphate, excipients. Paste B: Calcium Hydroxide, Zinc oxide, excipients	Chemical	106860571000	Septodont, France
2	Calcipulpe Paste (Calcipulpe)	Calcium hydroxide, Barium sulfate in a Methylcellulose base	Physical	B14554AB	Septodont, France
3	Cavity Liner, Paste Calcium hydroxide paste (cavity liner)	Calcium hydrox 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

the utilization of liner and base materials.[12]

A lot of research work has been done on the biological and mechanical properties of these materials,[13-15] and a very few studies are available on the setting time of these materials.[16-18] Whereas setting time is one of the major criteria for the selection of a lining material by a dentist.[11] The present study was conducted to evaluate the influence of humidity and temperature on the setting time of four different commercially available calcium hydroxide cements.

In order to replicate clinical situation, samples of each brand were allowed to set at 37°C and at relative humidity ≤ 90% (Group A) and at 25°C with relative humidity between 50-57% (Group B). The results showed that increasing the humidity and temperature to simulate oral environment without rubber dam (Group A) retarded setting. Though these results were in-contradiction to previously reported literature, that states the setting of calcium hydroxide cements is accelerated by moisture,19 they were consistent with results reported by Mc Michen et al.[20]

Detailed analysis of setting time showed that results of this study were in agreement with manufacturer's claims for light cure and two pastes system but variation was observed in other cements. Manufactures of each material used in the study claimed fast setting of calcium hydroxide cement that not only allow placement of final restoration over the cement in single visit but also reduces the possibility of dissolution of material by saliva, tissue fluids or blood.[16-18]

Although a similar behavior was observed for each brand of cement, however, there was no significant difference ($P<0.05$) between the setting time of light cure and two pastes system. In present study large variation in setting time was observed against manufacturer's claims for both cavity liner paste and calcipulpe, hence it fails to satisfy the standards used for cements.

Additionally, comparison of mean initial and final setting times of dental cements showed that light cured calcium hydroxide cement exhibited the smallest initial and final setting time followed by two pastes system, cavity liner paste and calcipulpe in both conditions. Extended setting time of cavity liner paste and calcipulpe can be attributed to the presence of excipients in the composition of both materials, that may interferes with the setting reaction of calcium hydroxide cement. The long setting time has previously been attributed to similar excipients but the study was unable to rule out the effect of humidity.[16,21]

Moreover, a significant difference was observed in means of setting time and change in environmental condition for both calcipulpe and cavity liner paste. Both materials showed shorter setting time in group A and B. However, no significant difference was observed for two pastes system and light cure calcium hydroxide. These findings may be related to a delayed evaporation of excipients in high humidity. The long setting time has previously been attributed to excipients such as methylcellulose but the study was unable to rule out the effect of humidity.[16,22]

A significant difference between groups (A and B) was observed, on comparing mean setting time using One Way ANOVA and pos hoc Tukey's test. Thus, emphasizing the use of rubber dam for all clinical procedures. Rubber dam should be used strictly for all procedures because it not only provides clean operating field but also protects patients from aspiration of different endodontic materials and instruments. Moreover, it also helps in moisture control.[23]

In a survey, Gregg reported that 63% of dentists did not use rubber dam for operative procedure. SA Feieraband et al also reported similar findings and further stated that high cost and technique sensitivity are responsible for these findings.[24] However, the results of our study, clearly shows that the use of rubber dam can significantly reduce relative humidity in setting environment of dental cement, thus reducing setting time.

It is recommended that the effect of different contaminants on the setting time may be evaluated for further assessment of these materials. This will enable better simulation of the clinical conditions. Also it will help to identify areas requiring special attention to enable implementation of successful dental care practices.

CONCLUSION

The results of the study clearly indicated the clinical significance of using rubber dam. Rubber dam reduces the setting time and the effect of contaminants on the calcium hydroxide based cements. This study also provides a guideline for the clinician to choose the type of calcium hydroxide needed in a particular situation based on determined setting times.

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1 Shahreen Zahid:	Designing of the study and statistical analysis
2 SamieQadir:	Performed experiment and assistance in data collection
3 Asfia Saeed:	Performed experiment and writer of the article
4 Muhammad Kaleem:	Supervisor

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