

Spectrophotometric evaluation of calcium ion release from different calcium hydroxide preparations: An *in-vitro* study.

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Receipt: 01/30/2017 **Revised:** 02/28/2017
Acceptance: 03/24/2017 **Online:** 03/24/2017

Conflict of interests: None.

Ethics approval: Approval was obtained from the institutional Ethical Committee (Research Protocol number RKDF/DC/2016/10103/B).

Funding: None.

Authors' contributions: Conception and design of the study, Data collection, Data analysis, Results interpretation, Article writing, Final editing and approval: Dr. Atul Jain, Dr. Kanchan Bhadoria, Data Collection Dr. Hemendra Singh Hada.

Acknowledgements: None.

Cite as: Jain A, Bhadoria K & Hada HS. Spectrophotometric evaluation of calcium ion release from different calcium hydroxide preparations: An *in-vitro* study. J Oral Res 2017; 6(3):61-63.
doi:10.17126/joralres.2017.021

Abstract: Pulp tissue conditions such as infections have long been treated with calcium hydroxide (CaOH). In the last decade, use of mineral trioxide aggregate (MTA) has gained ground. This study was carried out to comparatively evaluate the Ca release from CaOH powder with different vehicles and different types of MTA. **Materials and Methods:** 40 single rooted mandibular premolars were selected, decoronated and biomechanically prepared. They were randomly divided into four groups, consisting of 10 samples each. Root canals were packed with different preparations of CaOH and MTA. Calcium ion release was evaluated with an UV-spectrophotometer. **Result:** Amongst the CaOH preparations, using propylene glycol as a vehicle produced extended release of calcium ions (7.34±0.01) for a period of 14 days. Whereas, amongst MTA based products, MTA angelus produced the maximum release of calcium ions (2.42±0.010). A statistically significant difference was present between the four groups ($p<0.05$). **Conclusion:** Propylene glycol mixed with CaOH powder, produces a higher and extended release of calcium ions compared to distilled water. MTA angelus produces consistent calcium ion release.

Keywords: Calcium hydroxide; propylene glycol; pulp capping and pulpectomy agents; solubility.

INTRODUCTION.

Calcium hydroxide (CaOH) is the most widely used intracanal medicament nowadays.¹ The main actions of CaOH come from the ionic dissociation of Ca²⁺ and OH⁻ ions.² The vehicle plays an important role in the overall process because it determines the velocity of ionic dissociation.³ In general, three types of vehicles are used: aqueous, viscous and oily.

Mineral trioxide aggregate (MTA) is another agent, used in a wide variety of cases to overcome infections and seal the root canal and its perforations. It produces its effect by releasing calcium ions.⁴ MTA is biocompatible, non-toxic, insoluble in the presence of tissue fluids and is capable of producing a suitable environment for regeneration of periradicular tissues.⁵ Remaining dentin serves as a slow release system of intracanal MTA-derived Ca to the potential healing site. MTA Angelus has been launched commercially claiming better Ca release than the other MTA products.

CaOH powder with different vehicles and various commercial MTA products have been claimed to achieve higher calcium ions release. This *in-vitro* study was carried out to evaluate the amount of Ca released at various time intervals from CaOH within different vehicles and commercial MTA preparations.

MATERIALS AND METHODS.

For this *in-vitro* study, approval was obtained from the institutional Ethical Committee (Research Protocol number RKDF/DC/2016/10103/B). Freshly extracted permanent mandibular premolars were collected, cleaned and stored in distilled water. They were visually inspected and examined with Radio Visio Graph (Trophy Radiology, France). Forty single rooted premolars, free of defects with a single root canal were selected. Those with calcified canals, excessively wide canals, a severely curved root, external or internal resorption, developmental anomalies, fractured or craze lines root, roots with restoration, or previously endodontically treated teeth were excluded.

The selected teeth were decoronated, leaving a root of 14mm in length. Patency of the canal was established and working length was determined. Root canal was enlarged apically until #40 and coronally until #60 using Hand K files (Mani, Japan). Step-back technique was employed with circumferential filling and recapitulation. Prepared teeth were randomly and equally divided into 4 groups (n=10). Each group

was filled as following: Group I: CaOH powder mixed with distilled water in ratio of 6:4; Group II: Commercially available CaOH paste containing propylene glycol (Calexcel, Amdent, India); Group III: MTA Plus (Prevest-Denpro, Jammu, India) containing 75% Portland cement, 5% dihydrate calcium sulfate [Gypsum] and 20% bismuth oxide; Group IV: MTA Angelus (Londrina, PR, Brazil) containing 80% Portland cement and 20% bismuth oxide.

To keep the quantity of intracanal medicament equal, each root was filled up to 10mm and the remaining space was sealed with glass ionomer cement. Teeth were separately suspended in glass vial, in 10ml of distilled water with only the apical third immersed. 3ml of solution was withdrawn on day 1, 7, 14, and 28 and analysed with UV-spectrophotometer (Shimadzu Corp., Japan) at a wavelength of 235nm. The solution was placed in cuvette and the light was passed through it for analysis. The amount of light that passes through the solution is indicative of the calcium concentration. The collected data were subjected to statistical analysis using one-way analysis of variance test using SPSS 16.0 (IBM, USA).

Table 1. Calcium ion release for all time points and groups.

	Group I	Group II	Group III	Group IV	p-value
Day 1	6.12±0.15	5.76 ±0.01	2.42 ±0.01	8.27 ±0.01	0.005
Day 7	0.98 ±0.03	7.34 ±0.011	1.22 ±0.01	3.24 ±0.01	0.003
Day 14	0.76±0.02	2.65 ±0.02	2.07 ±0.01	2.17 ±0.01	0.003
Day 28	0.23±0.02	1.14 ±0.02	0.80 ±0.02	0.57 ±0.01	0.005
p-value	0.005	0.003	0.005	0.003	

RESULTS.

Calcium ion release for all days and groups are shown in Table 1. Statistically significant differences among all the groups and between different days were found.

DISCUSSION.

An aqueous vehicle promotes a high degree of solubility when the paste remains in direct contact with the tissue and tissue fluids, causing its rapid solubilisation and resorption by macrophages.² Whereas a viscous vehicle, due to its high molecular weight, promotes a lower solubility of the paste.² In our study, using an aqueous vehicle, the maximum calcium ion release was observed on

day 1 followed by gradual release until day 7. This was probably because distilled water being an aqueous vehicle, produced a high degree of solubility initially and once most of the Ca was released, its release tapered. Fulzele *et al.*,⁷ found that liberation of Ca and OH ions was faster and more significant when CaOH was mixed with distilled water.⁶

Ferreira *et al.*, in their study found that camphorated paramonochlorophenol and saline calcium hydroxide paste exhibited the highest calcium release and pH levels. On the contrary, Bayram *et al.*,⁸ found Ca release to be lowest with distilled water.

With propylene glycol, Ca release was found to be high-

est on day⁷ followed by a gradual release until day 28. This could be attributed to the high viscosity and low solubility of propylene glycol which results in a gradual release for a longer period of time. Larsen *et al.*,⁹ in their study found that paste containing CaOH with propylene glycol had better calcium ion releasing properties.

Using an aqueous vehicle, a root canal may be left devoid of Ca in a short period of time, delaying the healing process. From a clinical standpoint, this means that the root canal must be redressed several times until the desired effect is achieved, thereby increasing the number of appointments.

MTA Angelus displayed better and consistent release of calcium ions than MTA Plus. In contrast to our findings, Gandolfi *et al.*,¹⁰ found that MTA Plus produces higher and prolonged release of Ca. The probable reason for better release of Ca from MTA Angelus could be due the presence of a higher amount of Portland

cement, which is the primary source of calcium ions. It does not contain gypsum, being composed of only Portland cement (80%) and bismuth oxide (20%), in order to reduce setting time.⁴ This has been confirmed by Tanomaru *et al.*, who found Portland cement to produce higher calcium ion release. Similar to our findings, Salehimehr *et al.*,¹¹ also found higher calcium ion release from MTA Angelus. Pires-de-Souza *et al.*,⁴ compared new calcium aluminate cements and found that MTA releases more calcium ions.

CONCLUSION.

Calcium ion release is initially higher with MTA based products than CaOH powder preparations. CaOH powder mixed with propylene glycol has higher and extended release compared with CaOH mixed with distilled water. MTA Angelus has higher and more consistent calcium release than MTA Plus.

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