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

Atul Jain,¹ Kanchan Bhadoria,¹ & Hemendra Singh Hada.²

**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, nontoxic, 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.

---

**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
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).

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. Whereas a viscous vehicle, due to its high molecular weight, promotes a lower solubility of the paste. 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., 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., found Ca release to be lowest with distilled water.

With propylene glycol, Ca release was found to be high-
est on day 7 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.

**REFERENCES.**

1. Murvindran V, James D R. Antibiotics as an Intracanal Medicament in Endodontics. J Pharm Sci Res. 2014;6(9):297–301.
2. Fava LR, Saunders WP. Calcium hydroxide pastes: classification and clinical indications. Int Endod J. 1999;32(4):257–82.
3. Grover C, Shetty N. Evaluation of calcium ion release and change in pH on combining calcium hydroxide with different vehicles. Contemp Clin Dent. 2014;5(4):434–9.
4. Pires-de-Souza Fde C, Moraes PC, Garcia Lda F, Aguilar FG, Watanabe E. Evaluation of pH, calcium ion release and antimicrobial activity of a new calcium aluminate cement. Braz Oral Res. 2013;27(4):324–30.
5. Neelakantan P, Grotra D, Sharma S. Retreatability of 2 mineral trioxide aggregate-based root canal sealers: a cone-beam computed tomography analysis. J Endod. 2013;39(7):893–6.
6. Fulzele P, Baliga S, Thosar N, Pradhan D. Evaluation of calcium ion, hydroxyl ion release and pH levels in various calcium hydroxide based intracanal medicaments: An in vitro study. Contemp Clin Dent. 2011;2(4):291–5.
7. de Andrade Ferreira FB, Silva E Souza Pde A, do Vale MS, de Moraes , IG , Granjeiro JM. Evaluation of pH levels and calcium ion release in various calcium hydroxide endodontic dressings. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(3):388–92.
8. Bayram HM, Bayram E, Atakol O. Atomic absorption spectrometry evaluation of calcium ion release from different calcium silicate-based endodontic materials used with new irrigants. Biomed Res. 2016;(Special Issue):S333–6.
9. Larsen MJ, Hörsted-Bindslev P. A laboratory study evaluating the release of hydroxyl ions from various calcium hydroxide products in narrow root canal-like tubes. Int Endod J. 2000;33(3):238–42.
10. Gandolfi MG, Siboni F, Primus CM, Prati C. Ion release, porosity, solubility, and bioactivity of MTA Plus tricalcium silicate. J Endod. 2014;40(10):1632–7.
11. Salehimehr G, Nobahar S, Hosseini-Zijoud SM, Yari S. Comparison of physical & chemical properties of Angelus MTA and new endodontic restorative material. J App Pharm Sci. 2014;4(7):105–9.