# Comparitive Evaluation of pH and Calcium Ion Release in Newer Calcium Silicate Based Root Canal Sealers

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## Abstract

**Introduction:** The aim of root canal treatment is to provide three-dimensional obturation of the root canal system to prevent the entry of bacteria and fluid. Recent Calcium Silicate Sealers (CSS) have been claimed to be excellent sealers with alkaline pH, low solubility and providing good sealing owing to their setting expansion. To date, there are not enough publications that prove their physiochemical behavior.

**Aim:** The aim of this study is to evaluate and compare both pH and calcium ion release in newer calcium silicate-based root canal sealers.

**Material and Method:** We compared 3 commonly used calcium silicate sealers which were categorised as Group 1 (n = 5) control group, Group 2 (n = 10) sealapex, Group 3 (n = 10) mineral trioxide aggregate (MTA) fillapex, and Group 4 (n = 10) White MTA. The polyethylene tubes were prepared and materials were filled according to the groups made. The tubes were packed and flask was closed and stored at a constant temperature of 37°C during all the evaluation period at different intervals of 24 h, 7 days and 1 month. pH and calcium ion released was measured using pH meter and atomic absorption spectrophotometer, respectively.

**Results:** At 24 h, White MTA showed the highest pH and highest calcium ($Ca^{++}$) release. MTA fillapex maintained an alkaline ph even after 1 month of the study. MTA Fillapex showed the highest $Ca^{++}$ release even after 30 days that gradually increased aswell.

**Conclusion:** MTA Fillapex proves to show better alkalinizing ability and $Ca^{++}$ release of as compared to White MTA and (Sealapex) with increase in time intervals can be explained by greater solubility of MTA Fillapex with time as compared to the other two materials.

***Keywords:*** *Calcium silicate, filapex, MTA, sealapex.*

## Introduction

The aim of root canal treatment is to provide three-dimensional obturation of the root canal system to prevent the entry of bacteria and fluid.[1,2] To provide hermetic sealing, core materials such as gutta-percha (GP) and root canal sealers are essential.[3,4] The introduction of sealers with therapeutic properties applied in endodontics conceivably created prospective of a higher success rate of root canal treatment.

Properties like pH changes and released elements of root canal sealers have an impact on their clinical, biological and antibacterial behaviors. The alkaline pH is closely related to the increased hydroxyl and calcium ion ($Ca^{2+}$) release after root canal obturation, which

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inhibits growth of residual microbes, and this enhances healing of periapical pathosis.[5,6]

The use of calcium hydroxide clinically in the root canal was first reported by Rohner in 1940. Hence, the focus of research in sealers shifted toward calcium ($Ca^{++}$) based sealers due to their antimicrobial activity owing to their $Ca^{++}$ releasing potential. These sealers have been popularly used because of their potential for providing a high alkaline environment.

In 1993, at Loma Linda University, Dr. Torabinejad invented MTA. MTA is a complex blend of hydrophilic tricalcium silicate, tricalcium oxide, and tricalcium aluminate with added oxides (bismuth oxide).[8] Various studies have shown MTA to be biocompatible with the ability to stimulate mineralization and have the property of deposition of apatite-like crystals in dentin due to which its use was encouraged as a sealer.However, it has revealed specific drawbacks of extended setting time and challenging handling properties.[10] So as to recover some MTA drawbacks, numerous new calcium silicate-based materials have been invented.[11]

Latest among these sealers is MTA Fillapex. Which is basically MTA incorporated with salicylate resin, natural resin, bismuth, and silica. Their good handling property makes them easier to be used in the canal as a sealer. However, there is limited research regarding the physiochemical and biological properties of MTA Fillapex.[12]

Recent Calcium Silicate Sealers (CSS) have been claimed to be excellent sealers with alkaline pH, low solubility and providing good sealing owing to their setting expansion. To date, there are not enough publications that prove their physiochemical behavior. Hence, it is necessary to evaluate pH and $Ca^{++}$ release of these materials to analyze their alkalinization ability and induction of mineralization.

Therefore, this study was designed to evaluate pH and calcium ion release of a new calcium silicate-based sealer-MTA Fillapex and compare it with White MTA and the conventional calcium hydroxide-based sealer-sealapex.

## Material and Method

The root canal sealers tested in this study were Sealapex, MTA Fillapex and White MTA.N" polyethylene tubes were cut into 35 tubes of equal sizes; with each tube measuring 10 mm length × 1.0 mm diameter using bard parker blade and digital Vernier caliper. The tubes were pre-weighed and were prewashed with 5% nitric acid to prevent interference with phosphate ions and alkaline metals. The polyethylene mounted tubes were divided as: Group 1 ($n$ = 5)-control group-empty tubes, Group 2 ($n$ = 10)-tubes filled with Sealapex, Group 3 ($n$ = 10)-tubes filled with MTA Fillapex and Group 4 ($n$ = 10)-tubes filled with White MTA.

Fresh mixed sealers were prepared according to manufacturer instructions. The mixed MTA was carried into the polyethylene tube with the help of lentulo spiral. After complete filling of the tubes, the materials were condensed with the hand pluggers to avoid any voids in the inserted sealer. Subsequently, the samples were radiographed and those containing voids were discarded.

Subsequently, the samples were placed in polypropylene flasks, containing 10 ml of deionized water. The deionized water was verified for the total absence of calcium ions and the presence of neutral pH (6.8). The flask was closed with the lid, and the samples were stored in an incubator at a constant temperature of 37°C during all the evaluation period. At 24 h, 7 days and 1 month, the deionized water was measured for pH by a pH meter and released calcium ions were measured by atomic absorption spectrophotometer. Following each evaluation, the water was discarded, and the samples were immersed in fresh deionized water of similar amounts (10 ml).

**Statistical analysis:** According to the normality test, the data was statistically analyzed by the One-Way ANOVA and Post-Hoc Tukey HSD tests using SPSS software (Version 21.0; SPSS, Inc, Chicago, IL) at significance level of 5%, to compare the tested materials.

## Results

In the present study all the materials were evaluated for both ph and calcium release at three time intervals namely: after 24 hrs, after 7 days/ 1 week and lastly at 30 days or 1 month.

**Table 1: Comparitive pH Values of Study Materials at 24 Hours,7 Days and 30 Days.**

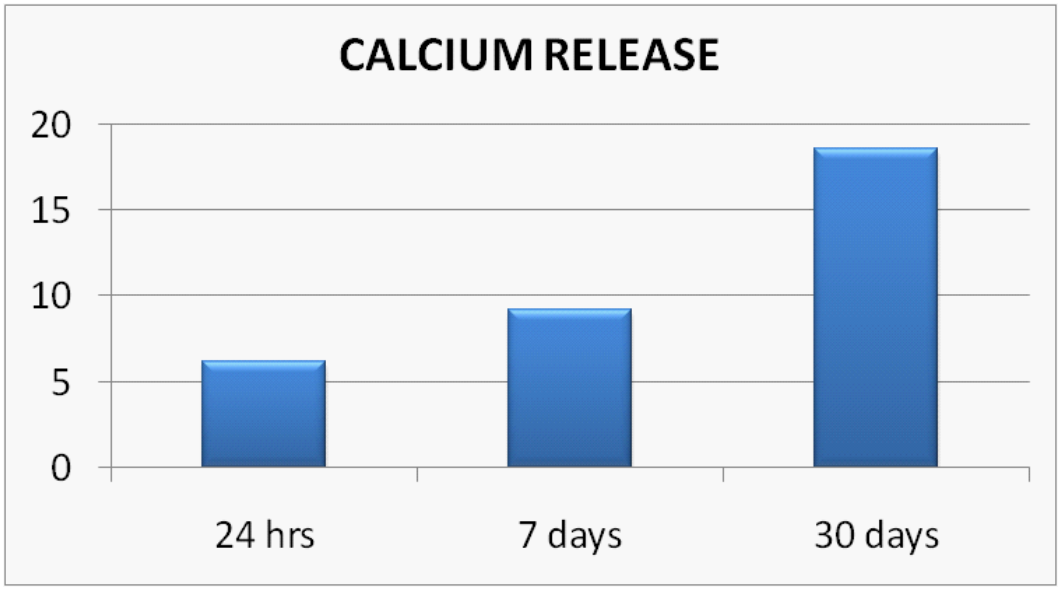
| Study Groups | Mean pH Values 24 hrs | Mean pH Values 7 Days | Mean pH Values 30 Days |
|---|---|---|---|
| Group 1 (N=5) | 6.87±0.14 | 6.90±0.02 | 6.88±0.05 |
| Group 2 (N=10) | 8.32±0.10 | 8.45±0.14 | 8.34±0.12 |
| Group 3 (N=10) | 8.29±0.05 | 8.68±0.08 | 8.74±0.10 |
| Group 4 (N=10) | 8.42±0.12 | 8.52±0.20 | 8.58±0.08 |

The results of mean pH values of all the study groups are compared in table 1. Our results showed that highest mean pH values observed at 24 h was shown by White MTA (group 4) with 8.42±0.12, Sealapex (group 2) with 8.32±0.10 and MTA fillapex (group 3) with 8.29±0.05. The highest mean pH values observed at 7 days and at 30 days was of MTA fillapex with 8.68±0.08 and 8.74±0.10 respectively. There was no statistically significant difference between pH of White MTA and sealapex. The difference in values of MTA Fillapex was significantly higher than other two groups ($P < 00001$).

Further table 2 demonstrated mean values of calcium release by all study materials. It was observed that The highest calcium ion release at 24 h was shown by White MTA (group 4) with 15.20±0..42 followed by group 2 i.e Sealapex with 9.04±0.08 and lastly least values were obtained from MTA Fillapex (group 3) with 6.21±0.10. Control group showed negligible $Ca^{++}$ release at all time periods (0.03). All the experimental materials showed $Ca^{++}$ release at all time periods. At 7 days, MTA Fillapex showed the highest $Ca^{++}$ release with 9.24±0.20, whereas, Sealapex showed significantly lowest calcium ion release with 8.02±0.12. At 30 days, the calcium ion release by MTA Fillapex was again the highest with 18.56±2.40. The difference the values of MTA Fillapexwhen compared with other groups was found to statistically highly significant ($P < 00001$).

**Table 2: Comparitive Mean Calcium Values of Study Materials at 24 Hours, 7 Days and 30 Days.**

| Study Groups | Mean Values 24 hrs | Mean Values 7 Days | Mean Values 30 Days |
|---|---|---|---|
| Group 1 (N=5) | 0.04±0.02 | 0.04±0.02 | 0.04±0.02 |
| Group 2 (N=10) | 9.04±0.08 | 8.02±0.12 | 6.89±0.28 |
| Group 3 (N=10) | 6.21±0.10 | 9.24±0.20 | 18.56±2.40 |
| Group 4 (N=10) | 15.20±0..42 | 8.32±0.42 | 9.86±2.10 |




**Graph 1: Comparitive Mean Calcium Values of MTA Fillapex at 24 Hours, 7 Days and 30 Days.**

When pH and calcium ion release at different time intervals was compared, it was found that Sealapex showed an almost conastant pH and gradual decrease in calcium ion release with increasing time intervals. MTA Fillapex in our study showed an increase in the pH and a significantly higher calcium ion release with an increase in the period.

## Discussion

The present study compared the change in ph and calcium release in three commonly used materials as Sealapex, MTA Fillapex and White MTA at three different time intervals.

With regard to the pH our study reported MTA fillapex to maintain an alkaline ph even after 1 month of the study. But there are controversies among studies when literature was reviewd. Some studies supported our finding as strongly alkalinity (pH range 10-12) that continued for four weeks after setting[13-15].

In yet another study, the initial pH of MTA-Fillapex was low in alkaline (pH = 9.3) that gradually declined over time to be 7.76 after 7 days.[16] It was believed that a strong alkaline pH may encourage a prolonged setting time which enhances a long-lasting antibacterial effect and eliminates the residual microbes that survive on the dentinal wall.[17]On contrary the pH value in the current study was found to be less than reported by Torabinejad *et al*. and Cutajar *et al*.[18]

Different pH values are observed with different formulations of MTA which can be explained on basis that calcium hydroxide present in MTA and MTA based sealers dissociates into $Ca^{++}$ and $OH^{-}$ ions, thus increasing the pH of the solution and because of this variation in the concentration of calcium hydroxide there is variation in pH as well. Furthermore, although both White MTA and MTA Fillapex are MTA based sealers, but the size of the polymer chain formed after setting may vary which may explain the difference in the result.

Further in our study, MTA Fillapex showed higher $Ca^{++}$ release which can be explained by the higher solubility of MTA Fillapex as was seen in the study by Borges *et al*. where the solubility of MTA Fillapex (14.85%) was more than Sealapex (5.65%). [19] In a study by Nassari MRG *et al*., Fillapex presented a solubility of 16.6% at 2 days and 15.03% at 7 days, whereas Sealapex exhibited solubility of 13.42% at 2 days and 9.97% at 7 days.[20] A decrease in solubility should manifest as a decrease in $Ca^{++}$ release and a decrease in pH.

The calcium ion release and, in consequence, the increase in pH values is closely related to setting time and solubility [21]. According to Parirock and Torabinejad [22], the presence of calcium may favor an alkaline pH, which leads to a biochemical effect that accelerates the healing process.

In 2013, Silva et al. suggested that due to high alkalinity of MTAFillapex,[16] it had a strong capacity to release hydroxyl ions, thereby causing a high $Ca^{2+}$ ion release. The alkaline media could activate the alkaline phosphatase, neutralize the acid, inactivate the osteoclasts, prevent the further bone destruction and allow tissue repair with concomitant apatite formation. The extreme alkalinity, however, can induce severe tissue cytotoxicity overtime. The significant difference in $Ca^{2+}$ released from the four brands of CSS confirmed its different alkaline pH values.[16]

## Conclusion

MTA Fillapex proves to show better alkalinizing ability and $Ca^{++}$ release of as compared to White MTA and (Sealapex) with increase in time intervals can be explained by greater solubility of MTA Fillapex with time as compared to the other two materials. However, further studies are needed to establish better and confirmed findings with a methodology which would probably better simulate the clinical situations.

**Conflicts of Interest:** The authors declare that there is no conflict of interest regarding the publication of this paper.

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