

Research Article

Comparison of Porosity in Thermoplastic Filling Using MTA with Ca(OH)₂ and MTA with Nano Chitosan by using Scanning Electron Microscope (SEM)

Dewa Made Wedagama

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Mahasaraswati Denpasar, Bali - Indonesia

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ABSTRACT

Introduction: Porosity often occurs after root canal treatment. Various sealers are used to close all the gaps between the root canal system and the outer surface of the tooth. The currently used root canal sealers include MTA, Ca(OH)₂, and nano chitosan (NC). The purpose of this study was to determine the difference in porosity levels of root canals treated with MTA sealer combined with Ca(OH)₂ versus MTA sealer combined with NC.

Method: This study used 16 human adult incisor samples (tooth #11), divided into two groups. The first group received MTA sealer with Ca(OH)₂, and the second group received MTA sealer with NC, both applied using the thermoplastic filling technique. After treatment, the samples were examined using scanning electron microscopy (SEM) to measure porosity.

Results: The porosity measurements (in micrometers, μm) for the first group (MTA with Ca(OH)₂) were: 12.24, 7.98, 9.81, 8.19, 10.85, 7.87, 8.43, and 8.96. The second group (MTA with NC) showed porosity values of: 7.73, 2.48, 6.80, 3.85, 1.32, 4.66, 3.98, and 4.22. The mean porosity in the first group was 9.29 μm , while in the second group it was 4.38 μm .

Conclusion: Statistical analysis showed a t-value of 5.31 with $p < 0.001$, indicating a significant difference between the two groups ($p < 0.05$). This suggests that MTA sealer combined with nano chitosan results in significantly lower porosity and better root canal filling density compared to MTA sealer combined with Ca(OH)₂.

Corresponding Author:

Dewa Made Wedagama

Department of Conservative Dentistry, Faculty of Dentistry

Universitas Mahasaraswati Denpasar, Bali – Indonesia

Email: wedagama_fkg@unmas.ac.id

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INTRODUCTION

Root canal treatment aims to remove necrotic pulp tissue and inflammation by filling the root canal and repairing the periapical tissue.^{1,2} The root canal obturation material should effectively seal the space within the hermetic root canal.³ Gutta-percha is considered the gold standard for root canal obturation, used along with a sealer to prevent leakage of the root canal system and provide antibacterial properties.^{4,5} Mineral Trioxide Aggregate (MTA) and calcium hydroxide (Ca(OH)₂) are commonly used sealer materials.^{6,7} Nano chitosan possesses biocompatible and biodegradable properties as well as favorable mucoadhesive characteristics, making it suitable for biomedical applications.⁸ This study aims to determine the difference in porosity levels between root canal fillings using MTA sealer combined with calcium hydroxide and MTA sealer combined with nano chitosan.⁸

MATERIALS AND METHODS

This study employed an in vitro laboratory experimental design with a posttest-only approach. Preparation, obturation, and tooth sectioning were performed in the pre-clinical room of the Faculty of Dentistry, Universitas Mahasaraswati Denpasar. Porosity testing, using Scanning Electron Microscopy (SEM), was conducted at the Central Laboratory FMIPA, Universitas Negeri Malang.

Sixteen adult human central incisor teeth (#11) were selected based on criteria that included the absence of caries and the presence of a straight root canal. The minimum sample size was calculated using Federer's formula: $(n-1)(t-1) \geq 15$, resulting in $n \geq 16$. The teeth were then divided into two groups. The first group received a thermoplastic filling technique using MTA sealer with Ca(OH)₂, while the second group used MTA sealer with nano chitosan. Sampling was done by purposive sampling, and the samples were subsequently tested using SEM.

The tools used in this research included a round diamond bur, a carborundum disc, a contra-angle handpiece, tweezers, an excavator, K-files, a lentulo spiral, an irrigation needle, and a spatula. The materials used were MTA, nano chitosan, and Ca(OH)₂. The MTA utilized was

a bioactive bioceramic endodontic sealer (e-MTA bioceramic sealer, Kids e-Dental), consisting of a very fine inorganic powder of tricalcium/dicalcium silicate.

The prepared central incisors were filled using a thermoplastic technique, with two different sealers in two distinct groups. Group 1 used MTA (e-MTA bioceramic sealer, Kids e-Dental) with Ca(OH)₂, and Group 2 used MTA (e-MTA bioceramic sealer, Kids e-Dental) with nano chitosan. A periapical X-ray was taken to evaluate the obturation results. For SEM analysis, the apical third of each tooth root was horizontally sectioned 3 mm from the apex using a carborundum disc, producing 1 mm thick slices. These slices were then tested with SEM to determine the porosity level of the two sealer types. Data were analyzed using the Shapiro-Wilk normality test and an independent samples t-test.

RESULTS AND DISCUSSION

This study used 16 samples, group 1 is the thermoplastic filling technique using MTA sealer (e-MTA bioceramic sealer, Kids e-Dental) with (Ca(OH)₂), and group 2 is root canal filling using MTA sealer (e-MTA bioceramic sealer, Kids e-Dental) with nano chitosan.

Table 1. Results of porosity testing with the SEM technique

| NO | Sealer MTA + Ca (OH) ₂ (μm) | Sealer MTA + Nano chitosan (μm) |
|----|--|---------------------------------|
| 1 | 12.24 | 7.73 |
| 2 | 7.98 | 2.48 |
| 3 | 9.81 | 6.80 |
| 4 | 8.19 | 3.85 |
| 5 | 10.85 | 1.32 |
| 6 | 7.87 | 4.66 |
| 7 | 8.43 | 3.98 |
| 8 | 8.96 | 4.22 |

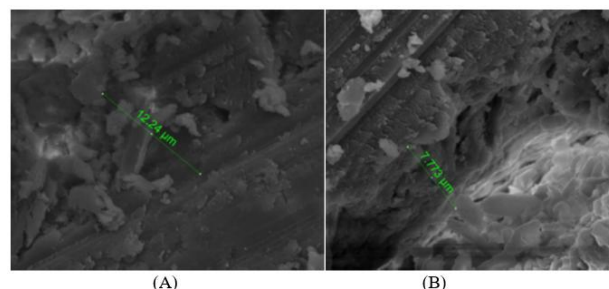


Figure 1: A. Porosity Result of MTA Sealer Samples with (CaOH)₂. B. Porosity Result of MTA Sealer Samples with Nano-Chitosan

Table 2. Normality test results

| | Kolmogorv-Smimov ³ | | | Shapiro Wilk | | |
|-----------------------------------|-------------------------------|----|-------|--------------|----|-------|
| | Statistic | df | Sig. | Statistic | df | Sig. |
| MTA Sealer | 0.209 | 8 | 0.200 | 0.869 | 8 | 0.147 |
| MTA + Ca (OH) ₂ Sealer | 0.197 | 8 | 0.200 | 0.953 | 8 | 0.743 |
| MTA + Nano Chitosan | | | | | | |

The significance values (p-values) from both tests were greater than 0.05, in both the Kolmogorov-Smirnov and Shapiro-Wilk tests. This indicates that the data from both groups are normally distributed.

Table 3. Independent t-test

| Kelompok | N | X (μ m) | SD | t | p |
|---------------------------------------|---|-----------------|------|------|--------|
| MTA Sealer MTA + Ca (OH) ₂ | 8 | 9.29 | 1.56 | 5.31 | 0.0001 |
| Sealer MTA + Nano Chitosan | 8 | 4.38 | 2.09 | 5.31 | 0.0001 |

There was a statistically significant difference ($p < 0.05$) in the mean sealer penetration (X) among the three treatment groups. The MTA sealer + nano chitosan group showed the lowest mean penetration (4.38 μ m) compared to the MTA sealer + Ca (OH)₂ group, which had a higher mean value (9.29 μ m). The identical *t*-value (5.31) with a *p*-value of 0.0001 in both groups indicates that the difference between the groups is significant. This suggests that the addition of nano chitosan to MTA sealer significantly reduces penetration compared to the addition of calcium hydroxide.

The primary ingredient, after being added with chitosan and applied to the rat tooth pulp, may cause a slight reversible pathological change.^{9,10} Statistic T-test on group 1 treatment ie 8 samples of thermoplastic root canal filling technique using MTA sealer with (Ca(OH)₂) the mean of porosity is 9.29 μ m with standard deviation 1.56 while group II treatment ie 8 samples for Thermoplastic root canal filling technique using MTA sealer with nano chitosan the mean porosity is 4.38 μ m with standard deviation 2.09. Statistically, *t* = 5.31 with a *P* value is 0.0001. The MTA + chitosan group had less microleakage

values compared to the MTA group, but was not statistically significant, and GIC + chitosan had less microleakage values compared to the GIC group and was statistically significant. This suggests that the MTA sealer, which is added with nano chitosan, has a better filler density.¹¹⁻¹³ This is also supported by research conducted by Vinay Kumar¹⁶, the use of MTA as a root canal obturation material can seal perforation of the third of the root canal, and can avoid endodontic surgery.¹⁴⁻¹⁶

CONCLUSION

Porosity experimental study using SEM (Scanning Electron Microscopy) test, there is a difference in porosity level between MTA sealer with calcium hydroxide (Ca(OH)₂) with MTA sealer with nano chitosan. The porosity level of the use of MTA sealer with nano chitosan is smaller than the MTA sealer with calcium hydroxide (Ca(OH)₂). Nano chitosan can be used as a root canal filler because of its advantages as a smart material, bioactive, biocompatible, and biodegradable to tissues. In performing the root canal filling stage, using MTA sealer with nano chitosan as root canal filler is a better choice.

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