INTRODUCTION

Calcium hydroxide (CaOH)–based intracanal medicaments have been commonly used for root canal disinfection (1). However, it is generally believed that complete removal of the CaOH–based medicament is not possible using conventional treatment modalities (2).

Passive ultrasonic irrigation (PUI) is a technique used to remove more CaOH–based medicament from the root canal system through acoustic streaming (3). Several PUI systems with different materials and designs are available in the endodontic market. Therefore, it is necessary to compare the efficacy of these systems for medicament removal.

The purpose of this study was to compare the efficacy of several PUI systems in removing a CaOH–based medicament using a novel standardized three-dimensionally printed model assembled with a human dentin specimen, which was introduced by our research team in 2021 (4).

MATERIALS & METHODS

Design and production of the root canal model

We selected a lower second premolar with a curvature of 20° according to Schneider’s method used CBCT scans. We designed the root canal to have a 0.06 taper and a 0.30-mm apical dimension using a 3D design program. Then, we prepared a slot in the interior aspect of the curve at 2-5 mm above the apex (Fig 2a).

Human dentin specimen preparation

We obtained 48 intact human lower premolars with similar shapes to the 3D-printed tooth model. We prepared the fragments so that they would fit into the groove in the model. Then, we made a standardized rectangular groove in the center of the specimen (depth: 0.5 mm, width: 1.0 mm) (Fig 2b).

The dentin specimens were placed into 3D-printed models (Fig 2c) and embedded in impression material to create a system with a closed end. Then, we injected a CaOH–based medicament (Calcipex®) into the root canal (Fig 2d).

Table 1. The irrigation systems and protocols used in this study

<table>
<thead>
<tr>
<th>Irrigation system</th>
<th>Irrigation protocol</th>
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<tbody>
<tr>
<td>Syringe-needle-irrigation (SN)</td>
<td>Root canal was irrigated with only 5% NaOCl for 30 s using a syringe and needle</td>
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<tr>
<td>CK (K&amp;B, Busan, Korea)</td>
<td>The medicament was removed using CK for 30 s under 5% NaOCl</td>
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<tr>
<td>Irrisafe (IS, Acteon, Mérignac, France)</td>
<td>The medicament was removed using IS for 30 s under 5% NaOCl</td>
</tr>
<tr>
<td>Endosonic Blue (EB, Maruchi, Ujan, Korea)</td>
<td>The medicament was removed using EB for 30 s under 5% NaOCl</td>
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Measurement of the coated area using stereomicroscopic analysis

The specimens were observed under a stereomicroscope (× 50) and photographed (Fig. 3). Then, the area coated by the medicament on the bottom of the groove was calculated using ImageJ with the following equation.

\[
\text{Area} = \frac{\text{mm}^2}{\text{mm}^2}
\]

Measurement of remaining volume using micro-CT analysis

The dentin specimen was scanned using a micro-CT. The scanned images were analyzed to measure the area of the material remaining in the groove in each portion with the following formula (Fig. 4).

\[
\text{Remaining volume} = \frac{\text{mm}^3}{\text{mm}^3}
\]

RESULTS

Collectively, we conclude that PUI systems with small dimensions that are manufactured as a single unit with a holding chuck show better results for the removal of CaOH–based intracanal medicaments from root canals. Notably, flexible Ni-Ti instruments such as EB are more advantageous for curved root canals. We also confirmed that the standardized 3D printed root canal model assembled with a dentin specimen has the potential to be used for various endodontic irrigation experiments.

CONCLUSIONS

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REFERENCES