

# Displacement of Apical Plugs Fabricated from Calcium Hydroxide Paste in Three Root Canal Filling Techniques

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## Abstract

**Objective:** The present study evaluated the displacement of calcium hydroxide apical plugs in the root canals of teeth with enlarged apical foramen subjected to three filling techniques: lateral condensation, a hybrid method, and a thermoplastic technique (Ultrafil).

**Methods:** The root canals of 30 extracted single-rooted human teeth were drilled in reverse order with no. 1-5 Gates-Glidden drills using a crown-down technique until the no. 1 drill passed through the apical foramen. The specimens were prepared with K files, beginning with a 50 K file and progressing until a 90 K file was visible 1 mm beyond the apex. Apical plugs were fabricated from calcium hydroxide paste, and the specimens were stored at 37°C at 100% humidity for 3 days. They were allocated into three experimental groups (n=10) according to the root canal technique. After filling, the specimens were incubated for 48 h at 37°C and longitudinally sectioned to assess apical plug displacement. Data was analysed by Kruskal-Wallis and Dun's tests.

**Results:** The hybrid method caused the largest average apical plug displacement (1.96 mm), followed by the lateral condensation technique (0.85 mm) and the Ultrafil system (0.59 mm).

**Conclusions:** According to the results obtained in this study, when a 5mm apical plug is fabricated using L & C paste, filling of the remaining root canal can be performed with lateral condensation technique, hybrid method or Ultrafil.

**Keywords:** Calcium hydroxide; Apical plugs; Lateral condensation; Hybrid method; Ultrafil

## Introduction

Endodontic treatment of permanent teeth diagnosed with pulp necrosis and incomplete root formation is a major dilemma for dentists. As described in several studies [1-3], the typical treatment comprises calcium hydroxide, alone or in combination with other materials such as canal dressing plied over several appointments. The procedure is chosen for its antimicrobial activity and ability to stimulate mineralized tissue repair. The success rate of this treatment is quite high, but this procedure has drawbacks; the technique requires multiple sessions because the calcified apical barrier formation requires a relatively long time. In addition, frequent replacement of the paste inside the root canal can traumatize the apical tissue [4]. An alternative treatment, such as an apical plug that reduces treatment time without affecting the success rate, is desirable [4].

The oil vehicle affects the physical properties of calcium hydroxide [5]; therefore, the present study evaluated the displacement of L & C paste apical plugs during three root canal techniques: the lateral condensation technique; a hybrid method; and the thermoplastic technique (Ultrafil).

## Material and Methods

The study was approved by the Institutional Review Board of Bauru Dental School. Thirty extracted single-rooted human teeth were evaluated. The specimens were stored in 10% formalin and kept moist before experimentation. Coronal access was created, and the canals were drilled with no. 1-5 Gates-Glidden drills (Dentsply-Maillefer Instruments SA, Ballaigues, Switzerland) in reverse order using a crown-down technique until the no. 1 drill passed through the apical foramen. The specimens were then prepared with K files (Dentsply-Maillefer Instruments SA), starting with a no. 50 file and progressing in grade until a no. 90 file could be visualized 1 mm distal to the root apex. The root canals were irrigated with 1 mL of 1% sodium

hypochlorite (Biodinâmica Química e Farmacêutica Ltd, Ibitiporã, PR, Brazil) during drilling. Each root canal was irrigated with 1 mL of 17% EDTA (Biodinâmica Química e Farmacêutica Ltd) for 3 min, irrigated with 5 mL of saline (Laboratório Tayuyna, Nova Odessa, SP, Brazil), and dried with paper points (Tanariman Industrial Ltd, Manacapuru, AM, Brazil).

The apical plugs were prepared using L & C paste according to the manufacturer's instructions. One portion of powder was mixed with 1 drop of olive oil and applied using a Lentulo spiral (Dentsply-Maillefer Instruments SA) at low speed until the entire root canal was filled. Then, small portions of the paste were removed until only a 5 mm apical plug was present. The apical plug measurements and positions were confirmed radiographically. The specimens were stored at 37°C at 100% humidity for 3 days.

The specimens were divided into three experimental groups according to filling technique comprising 10 specimens each: the lateral condensation technique; the hybrid method; and the thermoplastic technique using the Ultrafil system (Hygenic, Coltène Whaledent Inc., New Jersey, United States of America). Sealer 26 was used as the root canal filling sealer. (Dentsply Indústria e Comércio Ltd, Petrópolis, Brazil). Lateral condensation technique was performed using number 80

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inverted gutta-percha master cone (Tanariman Industrial Ltd) with R7 accessory cones (Tanariman Industrial Ltd). The cones were applied to the main root canal with an endodontic sealer using a number 30 K file (Dentsply-Maillefer SA Instruments). Approximately 5 to 6 accessory cones were inserted into each canal. The cones were cut to size with a heated Paiva condenser, and the filling material was condensed vertically using another cold condenser.

For the hybrid method, the initial procedures were identical to those in the lateral condensation technique. A total 3 to 4 accessory cones were inserted into the root canal. A number 80 gutta-percha compactor (Dentsply-Maillefer SA Instruments) was introduced into the canal, and applied clockwise at a contra-angle. After laminating the gutta-percha, the compactor was moved 4 mm towards the apical plug and retained for 1 s, then removed. The plasticized gutta-percha was condensed with a manual condenser, and excess material was removed with a heated condenser.

The thermoplastic technique was performed using the Ultrafil system, which comprises gutta-percha filled tubes, a syringe, and a plasticizer. There are three gutta-percha types with different viscosities included: regular set (low viscosity), which hardens in 30 min; firm set (moderate viscosity), which hardens after 4 min; and endoset (high viscosity), which sets in 2 min. The firm set gutta-percha was used to fill root canals. The cannula was attached to the syringe, and both were connected to the plasticizer, which heated to 70°C. Prior to gutta-percha injection, the sealant was applied to the root canal using a K file. After lamination, the gutta-percha was injected into the root canal until the canal was filled. The root canal was completely filled using vertical condensation. Notably, calcium hydroxide leakage occurred during closure in all specimen groups.

The specimens were stored in plastic containers and incubated at 37°C for 48 h. The roots were then sectioned longitudinally with carborundum discs to expose the apical plug and filling (Figure 1). The sections were supported on utility was in groups of five and photographed using a Canon EOS Rebel digital camera on a tripod, along with a plastic ruler as a reference (Figure 2). The apical plug displacement for each root canal filling technique was analysed using Image Tool 3.0. The data were statistically analysed using the non-parametric Kruskal-Wallis test to assess potential differences between the techniques and the Dunn's test to determine the significance of any differences. Significance was designated at  $p < 0.05$ .



Figure 1: Root sectioned with carborundum discs to expose the apical plug and the root canal filling.



Figure 2: Photograph used in the Image Tool 3.0 software for analyzing the displacement of the apical plugs.

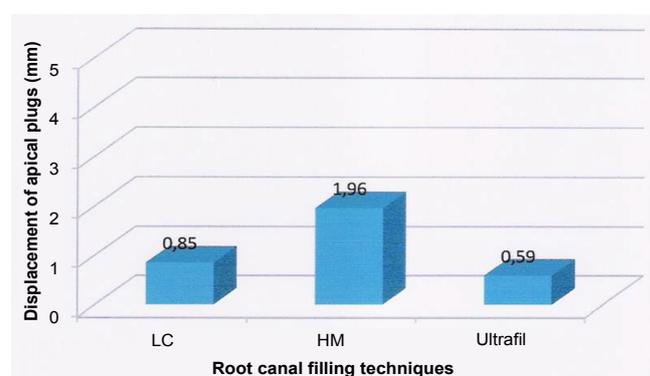


Figure 3: Average apical plug displacement (mm) according to root canal filling technique. LC; Lateral condensation; HM; Hybrid method.

## Results

Figure 3 summarizes the average apical plug displacement according to the root canal filling technique.

## Discussion

The calcium hydroxide apical plug, either alone or combined with other materials, is an alternative treatment for teeth with incomplete roots. Pitts et al. [6] compared apical plugs fabricated from powdered calcium hydroxide and dentin chips in their ability to prevent filling extrusion and observed that both effectively controlled extrusion, but most of the calcium hydroxide plugs became displaced from the root canal, while the dentin plugs remained in place during the nine month trial period.

In a 2005 study, Felipe et al. [7] evaluated the influence of continued replacement of calcium hydroxide paste containing propylene glycol on apexification and periapical repair in canine teeth with incomplete roots and previously contaminated canals. The results showed that calcium hydroxide paste replacement was unnecessary; this procedure alone significantly reduced inflammation. However, monthly replacement of the paste significantly also reduced apexification. Based on these prior studies, we chose L & C paste for the apical plugs. This paste has an olive oil vehicle, which according to Fava; Saunders [5] reduces solubility and enables gradual calcium hydroxide diffusion into the periapical tissues; thus, replacement is not required.

Furthermore, the olive oil prevents extrusion of the plug. Among the root canal techniques evaluated, the lateral condensation technique was chosen because it is the most commonly used technique for gutta-

percha condensation [8]. The hybrid method [9] is similar to the lateral condensation technique but also uses thermo-mechanical compaction as described by McSpadden. The technique was included to assess the apical plug's ability to prevent leakage of filling material. This technique could be used in teeth with incomplete roots formation by facilitating sealing [9]. The Ultrafil system was chosen because pre-plasticized gutta-percha shows excellent adaptation to the root canal walls [10,11]. This technique also avoids excessive apical pressure when it is properly performed.

The results showed that the hybrid method caused the largest average displacement of the apical plugs, followed by the lateral condensation technique and the Ultrafil system. However, there was no gutta-percha or cement leakage in any of the experimental groups. This finding, combined with the maximum displacement of 1.96 mm (hybrid method), indicates that all three techniques are feasible when used with an apical plug at least 3 mm thick. However, the L & C paste has a high pH and causes superficial coagulation necrosis on tissue contact, resulting in inflammation proportional to volume spilled [12]. The ideal filling technique would provide the least apical plug displacement.

## Conclusions

According to the results obtained in this study, when a 5mm apical plug is fabricated using L & C paste, filling of the remaining root canal can be performed with lateral condensation technique, hybrid method or Ultrafill.

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