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Evaluation of the Incidence of Transportation after Placement and Removal of Calcium Hydroxide

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The purpose of this in vitro study was to evaluate the incidence of apical transportation after the placement and removal of $Ca(OH)_2$ in straight and curved root canals. Twenty maxillary central incisors (group A) and 20 mesiobuccal canals from mandibular molars (group B) were instrumented at the working length to a #45 file and #30 file, respectively. Postinstrumentation radiographs were taken with the corresponding final file inserted into the canal to the working length. Afterward, the root canals were filled with a $Ca(OH)_2$ paste using Lentulo spirals, and the teeth incubated for 7 days. The $Ca(OH)_2$ paste was then removed up to the working length using a #45 file for group A and a precurved #30 file for group B. Final radiographs were taken with the file inserted into the canal to the working length. Postinstrumentation and final radiographs were superimposed to evaluate the incidence of transportation. As expected, in group A (straight canals) no transportation was detected, whereas in group B (curved canals) 9 of 20 canals showed apical transportation (95% confidence interval, 23.1–68.5% transportation). Statistically significant differences were observed between groups A and B ($p < 0.05$).

Cleaning and shaping is one of the most important goals of successful endodontic therapy. The persistence of necrotic tissue and microorganisms in the root canal are considered major etiologic factors for endodontic failures (1, 2).

Cleaning the root canal is accomplished by the combination of mechanical instrumentation, irrigation, and the use of intracanal medication (3). In this respect, calcium hydroxide ($Ca(OH)_2$) is a popular choice as an intracanal therapeutic dressing because of its antibacterial effect (4, 5). To facilitate its placement in the root canal space, $Ca(OH)_2$ should be used as a paste mixed with different media (6–8). To obtain a beneficial antibacterial effect, the $Ca(OH)_2$ paste should be properly condensed to ensure a homogeneous filling of the entire root canal (7, 9).

Although placement and removal of $Ca(OH)_2$ is simple in straight and large canals, this procedure could be difficult in curved and narrow canals. Furthermore, during the removal of the $Ca(OH)_2$ paste, it is possible that residual paste could remain at the apical portion of the root canal, affecting the apical patency during further instrumentation and obturation (10, 11). The purpose of this study was to evaluate the incidence of transportation produced after placement and removal of a $Ca(OH)_2$ paste in straight and curved canals.

MATERIALS AND METHODS

Forty extracted human teeth were used for this study. The teeth were separated into 2 groups of 20: group A, 20 maxillary central incisors; group B, 20 mandibular molars with moderate mesial root curvature. In group B, the mesiobuccal canal was used for this study.

In both groups, standard endodontic access was performed by using round burs. The coronal and middle thirds of the root canals were flared using #1, #2, and #3 Gates Glidden drills (Dentsply Maillefer; Ballaigues, Switzerland) for group A, and #1 and #2 Gates Glidden drills (Dentsply Maillefer) for group B. The canal length was visually established by placing a #10 file in each root canal until it was seen emerging through the apical foramen. The working length was determined subtracting 1 mm from the total length. The root canals were then instrumented at the working length to a K-file #45 (Dentsply Maillefer) in group A and to a precurved K-file #30 (Dentsply Maillefer) in group B. Three milliliters of 2.5% sodium hypochlorite solution was used for irrigation between each instrument and at the completion of instrumentation. The canals were dried with paper points.

The teeth were mounted in individual square pieces of high-consistency, condensation-curing silicone (Zetaplus; Zhermac, Badia Polesine, Rovigo, Italy), supported on a fixed platform to allow successive radiograph with a reproducible angulation to be taken. Postinstrumentation radiographs were taken from the buccolingual direction with the corresponding final file inserted into the canal to the working length.

Afterward, the root canals were filled with a $Ca(OH)_2$ paste (1 g of chemically pure $Ca(OH)_2$ powder (Farmadental, Buenos Aires, Argentina) mixed with 1 ml of normal saline). Lentulo spirals (#3 for group A and #1 for group B) in a slow-speed handpiece run at moderate speed was used to place the paste in the root canal until the dressing was detected through the apex. The $Ca(OH)_2$ paste was condensed by using Machtou's heat-carrier pluggers (Dentsply Maillefer).

Buccolingual radiographs were taken to determine that the fillings were dense and without voids. The access cavities were temporarily sealed with a cotton pellet and Cavit (Espe; GmbH, Seefeld, Germany). The specimens were stored in an incubator at 37°C in 100% humidity for 7 days. Then, the temporary seal was removed and the $Ca(OH)_2$ paste was cleaned from the canals up to the working length using K-files #20 to #45 for group A and precurved K-files #15 to #30 for group B. Calcium hydroxide was considered totally removed when no paste was recovered from the root canal. Twenty milliliters of 2.5% sodium hypochlorite solution was used for irrigation, which was performed using a disposable plastic syringe with a 27-gauge needle tip (Endo-Eze, Ultradent Products Inc., South Jordan, UT) inserted up to the middle third of the root canal. The canals were dried with paper points, and each tooth was repositioned on its square piece of silicone. A final radiograph with the corresponding file inserted into the root canal to the working length was taken under the same condition as the postintrumentation radiograph.

The postinstrumentation and final radiographs were mounted in slide mounts and projected onto drawing papers. The images of the postinstrumentation and final radiograph of each specimen were drawn on the same paper, superimposed according to the peripheral shape of the root. The preparation was considered acceptable (no transportation) when there was radiographic contact between the superimposed files in the apical 2 mm. The preparation was considered unacceptable (transportation) when there was divergence between the superimposed files in the apical 2 mm. Statistical analysis was performed by using confidence intervals with binomial distribution and Fisher's test.

RESULTS

In all straight root canals (group A), the comparison between postinstrumentation and final radiographs showed acceptable preparations without any sign of transportation. On the contrary, in curved root canals (group B), 9 of 20 canals showed unacceptable preparations, providing a calculated 95% confidence interval of 23.1% to 68.5% for transportation (Fig. 1). Based on statistical analysis, significant differences were observed between the groups ($p < 0.05$).

DISCUSSION

Calcium hydroxide is widely used as an intracanal therapeutic agent in endodontic therapy (12). In this study, $Ca(OH)_2$ paste was placed in the root canal using a Lentulo spiral. Studies show that this is the most effective method to obtain a deep and dense filling (7, 8).

Lambrianidis et al. (11), Porkaew et al. (13), and Çalt and Serper (14) showed the difficulty in removing $Ca(OH)_2$ dressing from the root canal. According to Lambrianidis et al. (11), $Ca(OH)_2$ paste was packed apically during the removal procedure, jeopardizing the outcome of the treatment.

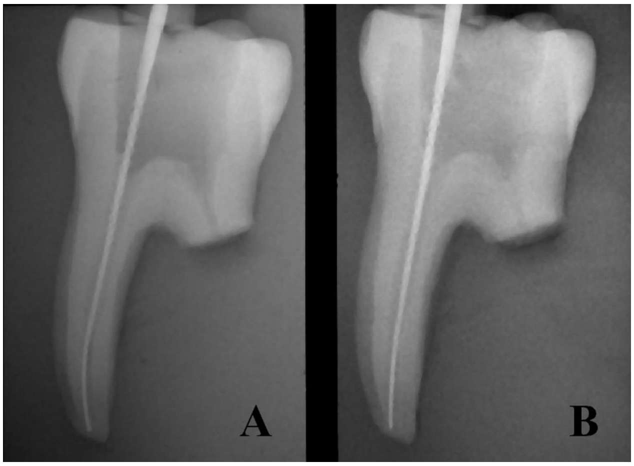

FIG 1. Group B: Radiographs showing an unacceptable preparation of the root canal. Apical transportation of the root canal can be observed comparing the postinstrumentation radiograph with a precurved #30 K-file inserted to the working length (A) and the final radiograph with the same file after the placement and removal of calcium hydroxide (B).

Although apical blockage is commonly caused by packing debris into the apical area, it also can be produced by any material that interferes with apical accessibility. During the removal of $Ca(OH)_2$, residual paste could block the apical area of the root canal, affecting the apical patency in curved canals. Buchanan (15) emphasized the importance of maintaining apical patency during endodontic treatment. On the contrary, when there is an apical blockage, the file will go in a straight direction transporting the canal anatomy. Likewise, White et al. (16) pointed out that the use of $Ca(OH)_2$ for 5 weeks causes the decrease in strength of root dentin. This situation could favor apical transportation when $Ca(OH)_2$ is used for a long period of time.

Some authors suggest the enlargement of the canal to the next file size to remove $Ca(OH)_2$ paste (13, 14). This procedure could be applicable in straight and large canals but would increase the possibility of transportation in curved canals.

Although $Ca(OH)_2$ is highly recommended as an intracanal medication, the findings of this study showed an important side effect to consider when $Ca(OH)_2$ is selected as a root canal dressing in curved canals.

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