Visualization Enhancement of Dentinal Defects by Using Light-Emitting Diode Transillumination

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Abstract

Introduction: Several recent studies have evaluated the presence of dentinal defects after root canal preparation in extracted human teeth by using the root sectioning methodology. The objective of this research was to investigate whether light-emitting diode (LED) transillumination enhances the visualization of dentinal defects by using a root sectioning methodology. **Methods:** Forty mesial roots of mandibular molars were sectioned at 3, 6, and 9 mm from the apex with a low-speed saw under water cooling. Microscopic pictures of the specimens were taken by using ×19.2 magnification for the 3-mm slice and ×12.8 magnification for the 6- and 9-mm slices. The LED transillumination was done by positioning an LED probe at 4 different locations (mesial, distal, buccal, and lingual). The root canal lumen was masked, and 2 independent evaluators assessed the presence of dentinal defects on the non-LED and LED images. The number of dentinal defects was recorded, and χ^2 test was used for statistical analysis ($P < .05$). **Results:** The number of slices presenting dentinal defects at 3, 6, and 9 mm were 2 (5%), 1 (2.5%), and 1 (2.5%), respectively, for the non-LED assessment and 8 (20%), 10 (25%), and 9 (22.5%), respectively, for the LED assessment. Overall, 4 of the specimens (10%) presented dentinal defects without LED evaluation, and 19 of the specimens (47.5%) presented dentinal defects with LED evaluation. This difference was statistically significant ($P < .05$). **Conclusions:** LED transillumination enhanced the visualization of dentinal defects in uninstrumented roots. The results from previous studies that used the traditional non-LED sectioning methodology should be evaluated with caution. *(J Endod 2016;42:1110–1113)*

Key Words

Crack, dentinal defect, endodontics, fracture, light-emitting diode

Significance

The presence of dentinal defects in teeth that underwent root canal therapy still needs to be understood. Dentinal defects can further develop into vertical root fractures, which usually lead to tooth extraction.

Root canal instrumentation is a crucial step in achieving a root canal space free of pulp tissue, bacteria, and by-products (1). Complications such as perforations, ledges, and instrument separation are a major concern during this procedure. It has been suggested that root canal instrumentation creates dentinal defects that may lead to a vertical root fracture (VRF) and ultimate tooth loss (2). A recent study evaluating the outcomes of apical microsurgery found that teeth presenting with dentinal defects observed by using light-emitting diode (LED) transillumination had an inferior outcome at both 1-year and 3-year follow-up (3).

Different methodologies have been used recently for the *in vitro* assessment of dentinal defects such as thermography (4), micro–computed tomography (micro-CT) technology (5), scanning electron microscope (6), and visualization of images of the apical surface (7). The assessment of pictures taken under magnification after root sectioning is the most commonly used methodology to evaluate *in vitro* the presence of dentinal defects after root canal instrumentation (8), root canal filling (2), and root canal retreatment (9). In this methodology, the roots are sectioned with a low-speed saw, and the presence of dentinal defects is evaluated under magnification (10). Uninstrumented roots are used as a negative control; recent studies that used the sectioning methodology have shown no defects in any specimens of these control groups (8, 10–14).

The major drawback of *in vitro* assessment methodologies is the possibility of having false-positive results because of extraction forces, storage, and sectioning procedures. All of these have the potential to create or propagate existing dentinal defects (15). Studies that have used the micro-CT methodology demonstrated that dentinal defects were present before the root canal preparation (5, 16). In addition, a recent study that used cadaver mandibles showed that uninstrumented control groups could also present dentinal defects observed after sectioning (17).

The objective of this research was to investigate whether LED transillumination enhances the visualization of dentinal defects by using a root sectioning methodology. The hypothesis is that root assessment of uninstrumented roots with the aid of LED transillumination will reveal dentinal defects that are not detected through the classic sectioning methodology.

Materials and Methods

Forty mandibular molars extracted for reasons not related to this study were used. Only teeth presenting with 2 canals, mature apices, and separate mesial and distal roots

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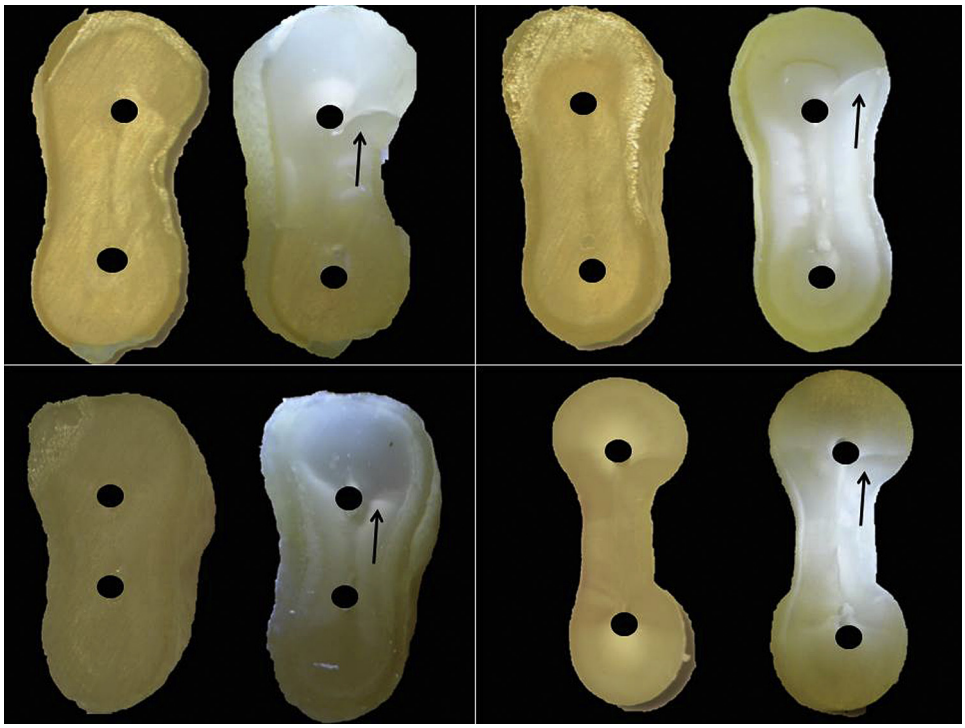

Figure 1. Specimens observed under magnification (*left*) and with the aid of LED transillumination (*right*); dentinal defect observed (*arrows*).

were included. An exempt status was approved by the Institutional Review Board Office of Human Research Ethics at the University of North Carolina at Chapel Hill.

All the roots were radiographed to exclude roots presenting curvature greater than 20°, calcified canals, or teeth presenting immature apices. In addition, teeth presenting with previous endodontic access were excluded from this experiment. The mesial roots were separated by using a carborundum disk (Brasseler, Savannah, GA) and inspected under ×12.8 magnification by using a dental operating microscope (Global G6; Global Surgical Corporation, St Louis, MO) to eliminate roots presenting external signs of microcracks. Roots were coated with impression material (Regisil; Dentsply Caulk, Dentsply International Inc, Milford, DE) and then imbedded in acrylic resin (Dentsply Caulk, Dentsply International Inc) to simulate the periodontal ligament (11, 18). After root canal access the canals were irrigated by using 5 mL 4.125% sodium hypochlorite (NaOCl) and negotiated by using a size 10 K-file (Dentsply Tulsa Specialties, Tulsa, OK). Only the canals in which the file could advance until the anatomic apex were included. All teeth were held in wet gauze during manipulation and kept in purified water to avoid dehydration.

After the selection of the specimens the roots were sectioned horizontally by using a low-speed saw (Isomet 1000; Buehler, Lake Bluff, IL) under water irrigation at 3, 6, and 9 mm from the apex. The slices were then photographed by using a camera (Nikon D5100; Nikon Corp, Tokyo, Japan) attached to the dental operating microscope. The slices obtained at 3 mm from the apex were photographed under ×19.2 magnification and the ones obtained at 6 and 9 mm with ×12.8 magnification.

The LED transillumination was done with the aid of a probe (TransCure-T; Kinectic Instruments Corporation, Bethel, CT) used at the buccal, lingual, mesial, and distal aspects of the specimens. The probe was used at 90° angles and within 1 mm of the external walls of the roots. Four different pictures were taken, considering each area that was transilluminated. The same magnification used for the observation of the specimens without LED transillumination was also applied for the LED transillumination.

A total of 120 images were obtained without the LED transillumination, and 480 images were obtained with the LED transillumination. The examiners were blinded to the fact that these roots were uninstrumented. To accomplish this, the images of the canal cross sections were blocked by adding a black circle covering the root canal space (Fig. 1). These images were randomly assigned to 2 experienced endodontist evaluators who were not involved in the preparation of the specimens. Every slice with dentinal defect was registered as 1 defect following the definition proposed by Shemesh et al (2). For the LED images, only 1 defect observed in any of the 4 pictures was necessary to include that specimen as having a defect. In case of disagreement the evaluators discussed the images until a consensus was reached. The χ^2 test was done for statistical analysis of differences between the 2 groups at significance level of .05.

TABLE 1. Comparison of Slices (n = 120) and Specimens (n = 40) Presenting Defects

	Total slices with defects	Total specimens with defects
Non-LED	4/120	4/40 (10%)[a]
LED	27/120	19/40 (47.5%)[b]

Values with different superscript letters were statistically different at P = .05.

TABLE 2. Number and Percentage of Slices with Defects at Each Level

	3 mm	6 mm	9 mm
Non-LED	2/40 (5%)	1/40 (2.5%)	1/40 (2.5%)
LED	8/40 (20%)	10/40 (25%)	9/40 (22.5%)