Light-emitting Diode Assessment of Dentinal Defects after Root Canal Preparation with Profile, TRUShape, and WaveOne Gold Systems

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Abstract

Introduction: The objective of this study was to use light-emitting diode (LED) transillumination to assess the presence of dentinal defects in roots instrumented with 3 different root canal preparation systems: ProFile (Dentsply Tulsa Dental Specialties, Tulsa, OK), TRUShape (Dentsply Tulsa Dental Specialties), and WaveOne Gold (Dentsply Tulsa Dental Specialties). **Methods:** Eighty mesial roots of mandibular molars presenting 2 canals were randomly divided into 4 different groups (n = 20) as follows: the control group, no root canal preparation was performed; the ProFile group, root canals were prepared with nickel-titanium ProFile sizes 20.06 and 25.06; the TRUShape group, root canals were prepared with nickel-titanium rotary TRUShape instrument sizes 20.06 and 25.06; and the WaveOne Gold group, root canals were prepared with the reciprocating WaveOne Gold instrument #25.07. The specimens were sliced at 3, 6, and 9 mm from the apex with a low-speed saw under water cooling. Microscopic pictures of the specimens were taken with the aid of LED; the root canal space was masked, and 2 independent evaluators assessed the images for the assessment of dentinal defects. The number of dentinal defects was recorded, and the chi-square test was used for statistical analysis ($P < .05$). **Results:** The number of specimens presenting dentinal defects was as follows: the control group = 10, the ProFile group = 10, the TRUShape group = 13, and the WaveOne Gold group = 10. **Conclusions:** Using the novel LED method, no difference in the visualization of dentinal defects was found among the ProFile, TRUShape, and WaveOne systems and the control group. Previous studies using the traditional sectioning method lack proper control and should be evaluated with caution. *(J Endod 2016;42:1393–1396)*

Key Words

Dentinal defects, light-emitting diode, Profile, TRUShape, WaveOne

Significance

It is still controversial if there is a relationship between root canal instrumentation, the creation of dentinal defects, and the development of vertical root fracture. Endodontists should be aware of the safety of root canal instrumentation systems in regard to the creation of dentinal defects.

Root canal instrumentation is an important step in root canal therapy aiming to remove pulp tissue, bacteria, and byproducts while maintaining the integrity of root canal walls (1). It has been hypothesized that root canal instrumentation might create dentinal defects (2), which may develop into vertical root fractures (3). A recent surgical study has shown that the presence of apical dentinal defects led to a poorer outcome (4). Light-emitting diode (LED) transillumination was used in that study to assist in locating these dentinal defects.

The sectioning method has been the most common way to evaluate root fractures caused by root canal instrumentation; with this method, teeth are sectioned at various distances from the apex, and the resulting sections are viewed under a microscope (5). These studies rely on an uninstrumented control group lacking visible dentinal defects after the sectioning (6). However, recent studies have shown that dentinal defects are common in uninstrumented roots and concluded that these defects could be caused by extraction, storage, and sectioning procedures instead of root canal instrumentation, thereby questioning the model (7–10). A previous study has assessed dentinal defects with LED transillumination in uninstrumented specimens (11). However, the assessment of defects in instrumented specimens using this methodology is still unknown.

Several *in vitro* studies have recently assessed the presence of dentinal defects after root canal instrumentation with different nickel-titanium (NiTi) rotary systems (12). In addition, the influence of reciprocating motion on the creation of dentinal defects has also been evaluated (13, 14). Recently, TRUShape (Dentsply Tulsa Specialties, Tulsa, OK) (15), a novel heat-treated NiTi rotary system, and WaveOne Gold (Dentsply Tulsa Specialties), a reciprocating system, were launched. To our knowledge, no study has yet evaluated the incidence of dentinal defects after root canal instrumentation with these new systems. We postulate the use of LED transillumination could better evaluate the presence of dentinal defects *in vitro* as it did *in vivo* (4).

Thus, the aim of the present study was to use LED transillumination to assess the presence of dentinal defects in mesial roots of mandibular molars after root canal instrumentation with different root canal systems. ProFile (Dentsply Tulsa Specialties), TRUShape, and WaveOne Gold were used as experimental groups; an uninstrumented

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group was used as a control. The hypothesis tested is that there are no differences in dentinal defects detected among the groups.

Materials and Methods

Eighty extracted mandibular molars kept in purified water were used in this study. An exempt status was approved by the Institutional Review Board Office of Human Research Ethics at the University of North Carolina at Chapel Hill, Chapel Hill, NC. Only teeth presenting separate mesial and distal roots, 2 separate and patent mesial canals, and mature apices with no previous endodontic procedures were included in this study. A dental operating microscope (Global G6; Global, St Louis, MI) was used to examine the selected experimental teeth and confirm that they were free of external cracks. Proximal and angled radiographs were taken to exclude teeth presenting curvature greater than 20°.

The distal roots were removed using a Carborundum disk (Brasseler, Savannah, GA), and access was gained with a diamond bur. The mesial roots of all 4 groups were irrigated with 5 mL 4.125% sodium hypochlorite (NaOCl), and the canals were negotiated with a size 10 K-file until apical patency was confirmed by visualizing the file tip through the apex. Roots were coated with impression material (Regisil; Dentsply Caulk, Dentsply International Inc, Milford, DE), embedded in an acrylic resin (Dentsply Caulk, Dentsply International Inc) to simulate the periodontal ligament, and kept in a moist environment during all the procedures. The 80 roots were then randomly distributed into 4 different groups: the control group (CG), ProFile group (PG) TRUShape group (TG), and WaveOne group (WG).

The CG was left uninstrumented. The PG, TG, and WG groups began treatment with the same glide path preparation. To standardize the groups and avoid any covariable between the 3 file systems, glide path preparation was performed 1 size larger than the manufacturer's guidelines. The glide path was performed using the following instruments: 13.02, 16.02, and 19.02 PathFiles (Dentsply Tulsa Specialties). The working length (WL) was established 1 mm short from the previously established patency length.

The PG was instrumented with ProFile instrument sizes 20.06 and 25.06. Instrumentation was begun with a 25.06 in a crown-down fashion, and then the canals were further instrumented by alternating between the 20.06 and the 25.06 until length was achieved. The motor was set at 300 rpm and 3 N torque. The instruments were used in 3 in-and-out motions using slight apical pressure and then removed and cleaned with gauze. The canal was irrigated with 3 mL NaOCl, and then a size 10 K-file was used to recheck patency. The instruments were used in the same fashion until the WL was reached.

The TG was instrumented with TRUShape instrument sizes 20.06 and 25.06. All procedures adopted were the same as in the PG group with the exception that the files in the TG were used in a sequential order.

The WG was instrumented with the WaveOne Gold 25.07 using an in-and-out motion with the "WaveOne ALL" setup of the motor. After 3 movements of at most 3-mm amplitude, the instrument was removed and cleaned with gauze. The canal was irrigated with 3 mL NaOCl, and then a size 10 K-file was used to recheck patency. The instruments were used in the same fashion until the WL was reached.

After instrumentation was completed, the roots were then sectioned using a low-speed saw (Isomet 1000; Buehler, Lake Bluff, IL) under water cooling at 3, 6, and 9 mm from the apex. Transillumination was performed with a TransCure-T LED probe (Kinectic Instruments Corporation, Bethel, CT) placed within 1 mm of the roots at the mesial, distal, buccal, and lingual aspects of the roots and resulting in 4 pictures for each root section. The 3-mm section was photographed under 19.2× magnification, and the 6- and 9-mm sections were photographed under 12.8× magnification using a dental operating microscope. Then, the root canal spaces of the pictures were masked with a round black cover in order to mask the evaluators regarding the instrumentation used.

The images obtained were randomly assigned to 2 experienced endodontists who were not involved in the preparation of the specimens to determine the presence or absence of dentinal defects. The calibration of the evaluators was performed previously to this project through the assessment of 720 images. Only 1 defect was necessary in any of the 4 pictures of each root section to consider that root section to have had a dentinal defect. The dentinal defect was defined as a disruption in the dentin surface (2). The specimens were then registered as having a defect or not having a defect. In cases of disagreement, the evaluators discussed the findings until a consensus was reached. The chi-square test was used for statistical significant differences at $P < .05$.

Results

A total of 960 images were assessed. The CG, PG, and WG presented 10 (50%) specimens with dentinal defects; the TG presented 13 (65%) specimens with dentinal defects. No statistically significant difference was found among the groups ($P > .05$). The number of defects present in the different sections is provided in Table 1.

Discussion

The root sectioning method has been used for the evaluation of dentinal defects after root canal instrumentation (16), root filling (17), and retreatment (18). The uninstrumented control roots in these prior studies presented no defects but were evaluated without the use of transillumination (19). When a source of light is applied on the root surface, it propagates through the dentin; if a defect is present, the light propagation is interrupted, thus enhancing the visualization of the defect (20). Our study used an LED transillumination methodology (11) to evaluate a traditional NiTi rotary instrument (ProFile), a novel heat-treated NiTi rotary instrument (TRUShape), and a reciprocating instrument (WaveOne Gold) (Fig. 1). The same tip and taper (25.06) were used for rotary instruments, and size 25.07 for the WG was chosen because it is the closest to the other rotary files systems tested.

Previous studies have reported the WaveOne Primary reciprocating instrument showed fewer dentinal defects when compared with the NiTi rotary ProTaper system (21, 22); others have shown more defects when reciprocating systems were compared with rotary

TABLE 1. The Number and Percentage of Slices with Defects at Each Level (n = 20)

Group	3 mm, *n* (%)	6 mm, *n* (%)	9 mm, *n* (%)	Total of specimens presenting defects, *n* (%)
Control	4 (20%)[a]	6 (30%)[a]	6 (30%)[a]	10 (50%)[a]
Profile	4 (20%)[a]	3 (15%)[a]	5 (25%)[a]	10 (50%)[a]
TRUShape	3 (15%)[a]	11 (55%)[b]	10 (50%)[a]	13 (65%)[a]
WaveOne	5 (25%)[a]	6 (30%)[a]	5 (25%)[a]	10 (50%)[a]

Values with the same superscript letter were not statistically different at P = .05.

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