The Effect of Using RC Prep during Root Canal Preparation on the Incidence of Dentinal Defects

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Abstract

Introduction: The purpose of this *in vitro* study was to evaluate the effect of using RC Prep (Well-Prep, Vericom Co, Anyang, Korea) during root canal preparation on the incidence of defects in root canal walls. **Methods:** One hundred extracted mandibular incisors with single canals were randomly divided into 1 control group and 4 experimental groups (n = 20). The teeth in group 1 (control) were coronally flared with Gates Glidden drills (Mani, Japan), but no further preparation was made. All teeth in the experimental groups were first coronally flared with Gates Glidden drills and then prepared similarly by means of ProTaper instruments (Dentsply Maillefer, Ballaigues, Switzerland). The difference between the experimental groups was the following: in group 2, saline was used as an irrigation solution without the application of RC Prep; in group 3, teeth were irrigated with saline, and RC Prep was also applied to canals before the insertion of each file; in group 4, sodium hypochlorite (NaOCl) was used for irrigation without the application of RC Prep; and in group 5, both NaOCl and RC Prep were used. The apical root surface and horizontal sections 3, 6, and 9 mm from the apex were observed under a microscope. The presence of cracks was noted. The chi-square test and Fisher exact test were used for statistical analysis of differences between and among the groups. **Results:** A significant difference was found between and among the 5 groups ($P < .05$). Group 4 (NaOCl), which had the highest number of cracked teeth, was significantly different from group 1 (control) ($P < .05$). RC Prep, with both saline and NaOCl, had no significant effect on the incidence of microcrack formation ($P > .05$). When data were pooled, regardless of whether RC Prep was used, there was a significant difference between saline (groups 2 + 3) and NaOCl (groups 4 + 5) ($P < .05$). **Conclusions:** RC Prep was unable to reduce the risk of dentinal defects. NaOCl caused more defects compared with saline. *(J Endod 2015;41:376–379)*

Key Words

Dentinal defect, microcracks, ProTaper, RC Prep

Because nickel-titanium (NiTi) was first introduced to endodontics in 1998 (1), advancements in NiTi rotary instruments have led to various design concepts and new techniques for root canal preparation (2–4). NiTi's superelasticity allows NiTi rotary instruments to be used in continuous rotation with a decreased incidence of canal transportation (5–7). Rotary instrumentation is associated with less apical extrusion of debris and microorganisms (8, 9) and requires less time compared with hand instrumentation (10).

Despite these advantages, instrumentation with NiTi rotary files can potentially induce microcrack formation in the canal walls at different levels along roots (11–14). In 1 study, up to 60% of prepared teeth showed dentinal microcracks (15). During instrumentation, the contact between instruments and dentin creates many momentary stress concentrations in dentin that may cause dentinal defects (16). Such stresses are transmitted through the root to the surface where they might overcome the bonds holding dentin together (17). It has been reported that stiffer file designs generate higher stress concentrations, which raises the risk of dentinal defects (16, 17). These dentinal cracks may have the potential to propagate into root fractures, which usually lead to tooth loss (17, 18). Furthermore, bacteria may proliferate in crack lines and later establish biofilms on the root surface (19). Therefore, there is a consensus that such defects should be prevented (13, 14).

During root canal preparation, lubricants are used for emulsifying and suspending the debris produced by the mechanical action of files. Although aqueous irrigants such as sodium hypochlorite (NaOCl) may serve as lubricants, paste-type substances are marketed especially for that purpose. The use of these paste-type preparations is also routinely recommended by rotary manufacturers tentatively to reduce stresses on instruments and/or improve hard tissue debridement (20). A photoelastic stress analysis study showed that using RC Prep as a lubricant during rotary instrumentation results in less internal root stress when compared with that associated with saline (21). Thus, it might be assumed that the incidence of dentinal defects might decrease when RC Prep is used during root canal instrumentation. Currently, no data are available to prove or disprove this assumption. Therefore, the aim of this *in vitro* study was to evaluate the effect of RC Prep on the incidence of dentinal defect formation after canal preparation.

Materials and Methods

The methodology used in this study has been described previously in the endodontic literature (15, 22, 23). Briefly, 100 extracted mandibular incisors with single canals were selected for use in this study. Buccolingual and mesiodistal radiographs were taken to verify the presence of the single canal and to exclude any

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teeth with cracks or fractures. Roots with calcified canals, an open apex, or anatomic irregularities were discarded. For the exclusion of any external defects or cracks, the external root surface was inspected by digital microscopy (Dino-lite Rack MS35 B; AnMo Electronic, Hsinchu, Taiwan). The crowns were removed 2 mm above the cementoenamel junction to achieve straight-line access and a reference plane. A silicon impression material was used for coating the root surfaces to simulate periodontal ligament space. The apical 3 mm of the roots were exposed to allow for image recording. The roots were randomly divided into 5 groups (n = 20). In all groups, a size 10 K-file (Mani, Tochigi, Japan) was introduced into each canal until it was visible at the apical foramen; the working length was determined at 1 mm shorter than the apical foramen. Before the initiation of instrumentation, a baseline image of the apical portion of each root was recorded by digital light microscopy (Dino-lite Rack MS35 B).

Cleaning and Shaping

One operator performed all root canal instrumentation. Group 1 served as the control group; just the coronal portions of canals were flared with no. 2 Gates Glidden drills (Mani), but no further instrumentation was performed.

In group 2, after enlargement of the coronal part of each canal with a no. 2 Gates Glidden drill, the ProTaper rotary drills (Dentsply Maillefer, Ballaigues, Switzerland) with a low-torque motor (NSK Endo-mate DT, Model NE131; Tochigi, Japan) at 300 rpm were used to prepare the canals. The Sx file was used to prepare the coronal half of the canal, and S1, S2, F1, F2, and F3 were used up to the working length. Each set of instruments was used for the preparation of 4 root canals. Between instrumentations, each canal was irrigated with 2 mL saline using a 27-G needle.

Groups 3, 4, and 5 were prepared similarly, except that in group 3 RC Prep was applied to canals before the insertion of each file, in group 4 canals were irrigated with 2.5% NaOCl (Golrang, Pakshoo Co, Tehran, Iran) instead of saline, and in group 5 canals were prepared with NaOCl and RC Prep.

At the end of the preparation procedures, another image of the apical portion of each root was recorded. The presence of any dentinal defect or cracks was determined by comparing the baseline and postinstrumentation images of each root.

Sectioning and Microscopic Observation

All roots were horizontally sectioned (Leica SP1600; Leica, Wetzlar, Germany) at 3, 6, and 9 mm from the apex. Slices were then viewed by digital microscopy (Dino-lite Rack MS35 B) with images taken at a magnification of ×20. Images were blindly checked by 2 operators for the presence of dentinal defects. "No defect" was defined as a section with no craze lines or microcracks at either the external or internal surface of the root canal. "Defect" was defined as any craze lines or microcracks observed in root dentin.

Statistical Analysis

A cracked root was determined if a dentinal defect was present in the apical surface or at 1 or more sections. The results were expressed as the number and percentage of cracked roots in each group. The chi-square test and Fisher exact test were used for statistical analysis of differences between and among the experimental groups. SPSS/PC version 16 (SPSS Inc, Chicago, IL) was used with a significance level of α = 0.05.

Results

No cracks were observed in the control group or in any of the baseline images of the apical portion of the experimental groups. Microcracks were found in all experimental groups. The results are shown in Table 1 and Figure 1.

There was a significant difference among the 5 groups (P = .027). Group 4 (NaOCl), which had the highest number of cracked teeth, was significantly different from group 1 (control) (P = .04). The differences between and among the other groups were not statistically significant (P > .05). Therefore, RC Prep, with both saline and NaOCl, had no significant effect on the incidence of microcrack formation. When data were pooled, regardless of whether RC Prep was used, there was a significant difference between saline (groups 2 + 3) and NaOCl (groups 4 + 5) (P = .045) (Fig. 2).

Discussion

In this *in vitro* study, extracted human mandibular incisors were used. All teeth were inspected by microscopy and with periapical radiographs for the exclusion of any teeth with cracks or fractures. Nevertheless, ruling out the presence of dentinal cracks before the start of the experiment was impossible because some cracks could be internal and not visible on the external surfaces of the roots (22). However, in the control group, no cracks were found, which implies that the sectioning method did not induce defects, and the cracks were a result of the instrumentation procedures.

In this study, the ProTaper system was selected for canal preparation because of its widespread use and because previous studies (15, 22, 23) reported a higher incidence of dentinal defects with this filing system than when other systems were used. In the present study, no statistically significant differences were observed between and among experimental groups, which implies that when ProTaper files are used for canal preparation, RC Prep is unable to reduce stress to the limit that prevents or reduces the incidence of dentinal defects. Although it has been reported that the application of RC Prep as a lubricant during canal preparation decreases internal root stress, the amount of stress reduction was different for different file systems. In fact, RC Prep caused a 64% reduction in stress with the GT ProFile system but only a 27% reduction with the ProFile system (21). Therefore, further studies are necessary to evaluate the effect of RC Prep or other lubricants/chelators on the incidence of dentinal defects with different rotary systems.

In the current study, the highest number of dentinal cracks (35%) was observed in group 4 (NaOCl) followed by group 5 (NaOCl + RC Prep). However, groups 2 (saline) and 3 (saline + RC Prep) showed the fewest cracks. Although no significant differences were detected between and among these 4 groups, this result should be interpreted

TABLE 1. Distribution of Teeth with Cracks per Group at Different Positions

		Number of teeth with cracks observed at different positions			
	n	Apical portion only	Section only	Both	Total (%)
Control	20	0	0	0	0 (0)
Saline	20	1	1	0	2 (10)
Saline + RC Prep	20	0	2	0	2 (10)
NaOCl	20	1	5	1	7 (35)
NaOCl + RC Prep	20	1	3	0	4 (20)
Total	100	3	11	1	15 (15)