Periapical Microsurgery: Can Ultrasonic Root-end Preparations Clinically Create or Propagate Dentinal Defects?

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Abstract

Introduction: This clinical study evaluates the effect of ultrasonic root-end preparations on dentinal defect creation and propagation. Methods: Eighty-four teeth were treated with peripical microsurgery using a modern microsurgical protocol in a private practice setting. The root apices were resected and inspected for dentinal defects with a surgical operating microscope and a 0.8-mm diameter light-emitting diode microscope diagnostic probe light, both before and after ultrasonic root-end preparations. A 3-grade scale (none, partial, and full dentinal defect) was used to assess the status of the roots before and after ultrasonic root-end preparation. Results: Of the 84 treated teeth, 3 had a vertical root fracture, leaving a total of 81 teeth for assessment. Fifty-one teeth were intact upon resection and remained intact after root-end preparation. Twenty-six teeth had partial dentinal defects, and 14 (54%) of these propagated into full dentinal defects after root-end preparation. Conclusions: This peripical microsurgery study showed that ultrasonic root-end preparations are safe to use on intact roots. Preexisting dentinal defects can be propagated by ultrasonic root-end preparations. Through the use of light-emitting diodes, dentinal defects can be detected, special root-end management can be implemented, and more predictable outcomes may be achieved. (J Endod 2016;42:1472-1475)

Key Words
Dentinal defect, endodontic microsurgery, fracture, root-end preparation, ultrasonics

Significance

Periradicular microsurgery is an important treatment option in modern endodontics. Dentinal defects have been shown to negatively affect treatment outcomes in periapical microsurgeries. This study investigates the effect of ultrasonic root-end preparation on the creation and propagation of dentinal defects in a clinical peripical microsurgery model.

Materials and Methods

Case Selection

The study subjects were patients in need of periapical microsurgery in an endodontic private practice setting. Each was enrolled consecutively between 2009 and 2010. Patients were informed in detail about the surgical procedure and were instructed about postoperative care, follow-up examinations, and available alternative treatment options. Informed, written, signed consent was acquired from all participants according to the Declaration of Helsinki, and exempt status for the study was approved by the Institutional Review Board Office of Human Research Ethics.

Radiographs of all teeth were exposed (Gendex GX 770; Gendex Dental Systems, Lake Zurich, IL) using a digital sensor (Visualix eHD, Gendex Dental Systems, Lake Zurich, IL) and paralleling devices (Dentsply Rinn, Elgin, IL). A straight periapical radiograph was taken along with a second 20° distal angled view. All root-filled cases diagnosed with symptomatic or asymptomatic apical periodontitis as defined by the American Association of Endodontists Consensus Conference Recommended Diagnostic Terminology (21) were included. Teeth with severe periodontal mobility (class II or greater), furcation involvement, localized probing defects greater than 5 mm, and any form of perforations were excluded from the study.
Surgical Phase

All the experimental, microsurgical procedures in this study were performed using direct vision principles through a surgical operating microscope (Global G6 Microscope; Global Surgical Corporation, St Louis, MO) (3, 22, 23).

After achieving anesthesia, a full-thickness periosteal flap was reflected, and a bony window was prepared. Granulation tissue, when present, was carefully curetted from the periapical region of each root. Rascal epinephrine pellets (Pascal Co, Bellevue, WA) were applied with pressure in the bony crypt for 5 minutes to obtain hemostasis (24). Three millimeters of the root ends were resected as perpendicular as practical to the long axis of the root (25). After resection, the root tips were smoothed and polished with a carbide Endo Z bur (Brasseler USA, Savannah, GA). Finally, an application of methylene blue stain confirmed the completed root resection indicated by the 360° presence of periodontal ligament surrounding the root. The initial baseline inspection (before the root-end preparation) was performed at this stage with direct vision through the surgical operating microscope and an HD Micro Surgical Mirror (JEDMED, St Louis, MO). Transillumination of the root tip was performed to help with the examination process using a 0.8-mm head diameter light-emitting diode (LED) microscope diagnostic probe light (Q-optics Quality Aspirators, Duncanville, TX). Root-end preparations of 3-mm depth were then prepared using ProUltra diamond-coated surgical ultrasonic tips (Dentsply Mailfer, Johnson City, TN) powered by a Satelec P5 ultrasonic unit (Acteon, Mount Laurel, NJ) according to the manufacturer’s instructions. All ultrasonic tips were used with a featherlike back-and-forth movement to reach the length and circumferentially clean the root-end anatomy. Ultrasonic tips were discarded after 9 roots or when the diamond coating was lost. The root-end cavities were rinsed, dried with a Stropko irrigator (SybronEndo Corporation, Orange, CA), and prepared for the final inspection with direct vision through the surgical operating microscope and the HD Micro Surgical Mirror. Transillumination of the root tip was redone in a similar fashion using the 0.8-mm head diameter LED microscope diagnostic probe light (Q-optics Quality Aspirators) (Fig. 1).

To avoid confusing definitions such as microfractures, microcracks, incomplete cracks, and craze lines, 2 distinct categories were defined by Shemesh et al (7). Intact was defined as root dentin on the resected root end devoid of any lines or cracks either on the external surface of the root or within the internal root canal wall. This “intact” group served as the control group. Dentinal defects were defined as all lines that appeared to disrupt the integrity of the dentin on the root-end surface that extended either from the external root surface onto the resected dentin surface or from within the root canal lumen onto the resected root surface (7). Defects were classified as partial or complete (Fig. 2). None of the dentin defects as defined in this study exhibited staining from methylene blue or resulted in a tactile catch when an explorer tine was passed across the defect. After the inspection was completed and documented, Gray MTA (Dentsply Mailfer, Johnson City, TN) root-end fillings were placed. The wound area was debrided and irrigated, the reflected soft tissues were repositioned, and primary wound closure was accomplished with interrupted 5-0 Chromic Gut Sutures (Hu-Friedy, Chicago, IL). The patients returned 5 to 7 days postoperatively for checkups and suture removal.

Figure 1. Transillumination of the root tip using a 0.8-mm-diameter LED microscope diagnostic probe light.

Figure 2. Classification of defects.
Clinical Research

The logistic regression analysis indicated that sex, location, and age were not statistically associated with the change of root status.

### TABLE 1. Test of Symmetry for Ultrasonic Effect on Root-end Status: Before Versus after Ultrasonic Root-end Preparation

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
<th>Full defect</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No defect</td>
<td>Partial defect</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>No defect</td>
<td>51</td>
<td>0</td>
<td>51</td>
</tr>
<tr>
<td>32.11</td>
<td>7.56</td>
<td>11.33</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Partial defect</td>
<td>0</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>16.37</td>
<td>3.85</td>
<td>5.78</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>46.15</td>
<td>53.85</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td>100</td>
<td>77.78</td>
<td></td>
</tr>
<tr>
<td>Full defect</td>
<td>0</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2.52</td>
<td>0.59</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>22.22</td>
<td></td>
</tr>
</tbody>
</table>

**Statistical Methods**

Bowker’s test for symmetry was used to evaluate whether the discordances in the defects from preultrasonic root-end preparations to postultrasonic root-end preparations were greater than what was expected by chance. Unconditional multivariate logistic regression was used to look for any potential association because of sex (male vs female), location (anterior teeth vs posterior teeth), and age (<40 vs ≥40 years). All statistical analyses were performed using SAS version 9.3 (SAS Institute Inc, Cary, NC). The a priori type 1 error rate for all statistical tests was set at alpha = 0.05.

**TABLE 2. Case Distribution: before/after Ultrasonic Root-end Preparation**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Teeth</th>
<th>No defects</th>
<th>Partial defect</th>
<th>Full defect</th>
<th>Fracture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37</td>
<td>22/22</td>
<td>11/6</td>
<td>1/6</td>
<td>3/3</td>
</tr>
<tr>
<td>Female</td>
<td>47</td>
<td>29/29</td>
<td>15/5</td>
<td>3/12</td>
<td>0/0</td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior</td>
<td>43</td>
<td>29/29</td>
<td>10/4</td>
<td>3/9</td>
<td>1/1</td>
</tr>
<tr>
<td>Posterior</td>
<td>41</td>
<td>22/22</td>
<td>16/8</td>
<td>1/9</td>
<td>2/2</td>
</tr>
<tr>
<td>Age (y)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;40</td>
<td>53</td>
<td>31/31</td>
<td>19/10</td>
<td>1/10</td>
<td>2/2</td>
</tr>
<tr>
<td>≥40</td>
<td>31</td>
<td>20/20</td>
<td>7/2</td>
<td>3/8</td>
<td>1/1</td>
</tr>
</tbody>
</table>

The logistic regression analysis indicated that sex, location, and age were not statistically associated (P > .05) with the change of root status.

**Results**

A total of 84 teeth were treated; 3 teeth had vertical root fractures before the ultrasonic root-end preparation and were excluded from the statistical analysis. Of the 81 teeth, 51 were intact upon resection and remained intact after root-end preparation. Twenty-six teeth had partial dentinal defects, and 14 (54%) of these propagated into full dentinal defects after root-end preparation. Bowker’s test for symmetry (Table 1) showed that the discordance in the type of defect before and after the use of root-end ultrasonic preparation was statistically significant (P < .05). Of those roots that had no defect before ultrasonic usage, all remained intact after. However, of those who had a partial defect before, 54% developed a full defect. The logistic regression analysis indicated that sex, location, and age were not statistically associated (P > .05) with the change of root status (Table 2).

**Discussion**

The purpose of this study was to clinically evaluate the effect of ultrasonic root-end preparation on the creation and propagation of dentinal defects. It showed that ultrasonic root-end preparations are safe to use on intact roots, but preexisting dentinal defects can be propagated by ultrasonic root-end preparations.

The fact that intact roots were not affected by the use of ultrasonic energy supports the theory that the periodontal ligament and surrounding bone have the capacity to attenuate the effects of ultrasonic preparation on crack formation (15).

Predictable treatment is a key objective in endodontics. To conserve teeth through apical microsurgery, a strategy must be developed to better manage dentinal defects. Creating a management protocol for these defects will increase the predictability of endodontic microsurgery in the years ahead.

This study used a 0.8-mm head diameter LED diagnostic probe light to obtain transillumination. Clinicians are strongly encouraged to routinely incorporate the use of transillumination through a microscopic LED light to systematically determine the integrity of root apices during periapical microsurgeries. Through the use of LEDs, dentinal defects can be predictably detected, and special root-end management can be taken. The decreased clinical outcome caused by dentinal defects has been shown in a previous study (5), and special root-end management should be undertaken when observed. The fact that ultrasonic root-end preparation can propagate these existing defects suggests that a higher root resection should be considered to eliminate the dentinal defect before proceeding with the ultrasonic root-end preparation. Through the use of LEDs, dentinal defects can be detected, special root-end management can be implemented, and more predictable outcomes may be achieved (3).

**Conclusion**

This periapical microsurgery study showed that ultrasonic root-end preparations are safe to use on intact roots. Preexisting dentinal defects can be propagated by ultrasonic root-end preparations. Clinicians are encouraged to incorporate the use of transillumination with a microscopic LED light to systematically determine the integrity of root apices during periapical microsurgeries.

**Acknowledgments**

The author denies any conflicts of interest related to this study.

**References**


