

# Cervical Root Resorption following Bleaching of Endodontically Treated Teeth

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**One year following root canal treatment and internal etching and bleaching of anterior teeth in dogs, the animals were sacrificed and the teeth prepared for stereomicroscopic or light microscopic examination. Evidence of cervical root resorption and ankylosis was noted on several teeth. The bleaching factors associated with the teeth exhibiting resorption were heat with 30% hydrogen peroxide. Resorption was not related to walking bleach or to internal etching alone.**

Discoloration of endodontically treated teeth is of concern to the patient and dentist. The causes most commonly cited for acquired intrinsic tooth discoloration are intrapulpal hemorrhage, pulp necrosis, intracanal medicaments, obturation materials and sealers, and metallic restorations placed in the coronal access (1).

Various methods have been reported in the literature for bleaching discolored teeth. Spasser (2) recommended placing sodium perborate alone into the pulp chamber. Nutting and Poe (3) modified this by mixing the sodium perborate with 30% hydrogen peroxide ( $H_2O_2$ ) and placing this paste in the pulp chamber for a specified period of time. In 1980, Howell (4) suggested that acid etching the dentin internally would "open" the dentinal tubules to allow better penetration of the bleaching agent. Others (5, 6) have recommended similar techniques which also include the application of heat to the oxidizing agent in the chamber, reportedly to enhance the bleaching effects.

In 1979, Harrington and Natkin (7) reported seven cases in which severe cervical root resorption was observed following internal bleaching of teeth treated endodontically secondary to trauma. In all cases both a bleaching chemical and heat were used. Other authors (8-12) have reported similar resorption, although a history of trauma was not always mentioned nor were the specifics of the bleaching techniques known.

These studies supply ample evidence that internal bleaching procedures may invoke external cervical resorption. However, what is *not* known is the factor or factors that constitute the etiology(ies) of this resorption. It seems apparent that some aspect of the procedure, possibly in combination with the previous trauma, damages the cementum and/or periodontal ligament.

The purpose of this study was to examine the effects of various factors used in bleaching techniques on the initiation of external root resorption in an animal model. Specifically, three bleaching techniques were used, with and without internal dentinal acid etching, following root canal therapy in anterior teeth in dogs.

## MATERIALS AND METHODS

### Materials

Forty-five maxillary and mandibular anterior teeth in five adult beagle dogs were used and assigned to the following control and experimental groups: controls—no root canal treatment (RCT), no bleaching (five teeth); RCT only, no etching and no bleaching (five teeth); experimental (etched + RCT)—thermocatalytic bleached (five teeth), walking bleached (five teeth), combination (five teeth), and no bleaching (five teeth); experimental (non-etched + RCT)—thermocatalytic bleached (five teeth), walking bleached (five teeth), and combination (five teeth).

### Methods

Oral prophylaxis was performed on all incisors. In an attempt to ensure that there was no preexisting marked cervical resorption and as a comparison for future radiographs, preoperative radiographs were taken. Root canal treatment was performed in one sitting. All of the pulps were vital upon entry. Under rubber dam isolation, access openings were on the facial surfaces and canal length was established radiographically. Cleaning and shaping was performed with K-type files and copious sodium hypochlorite irrigation using the step-back flaring technique. After preparation, the canals were dried and obturated with laterally condensed gutta-percha and Roth's sealer (Roth International, Ltd., Chicago, IL). Postoperative radiographs were then taken to assess and ensure adequate obturation.

Internal coronal bleaching on the experimental teeth was by one of three techniques. Twenty teeth were acid etched internally before bleaching. The bleaching techniques used in this study included: (a) *Thermocatalytic bleaching*—30%  $H_2O_2$  on a cotton pellet was placed into the chamber and heated for 1 min at 145°F with a Bleaching Instrument (Union Broach, New York, NY). A fresh pellet with 30%  $H_2O_2$  was

placed and heated three times at 2-min intervals. (b) *Walking bleach*—A thick paste of 30% H<sub>2</sub>O<sub>2</sub> and sodium perborate was placed into the chamber and sealed for 1 wk. (c) *Combination*—Thermocatalytic bleaching (as described above) was followed by placement of walking bleach paste.

All bleaching procedures were performed twice at a 1-wk interval. IRM was the interim temporary restoration. Following bleaching, the access preparations were sealed with acid-etched composite resin. At 3-month intervals, the animals' teeth were cleaned and periapical radiographs taken.

There was a 1-yr observation period after initiation of treatment. After taking periapical radiographs, the dogs were sacrificed and the teeth and tissues were prepared for direct observation and histological examination.

### Preparation of Samples

One-half of the teeth, with representative samples from each control and experimental group, were extracted and their surfaces carefully cleaned of periodontium. The root surfaces were examined under the stereomicroscope for evidence of cervical defects or other evidence of resorption. Those showing surface defects were decalcified and processed histologically. The blocks were cross-sectioned through the defect and examined with light microscopy to verify resorption (presence of significant loss of tooth structure and Howship's lacunae).

The other one-half of the teeth were removed in block section to include surrounding periodontium. The specimens were prepared histologically and cross-sectioned in the cervical root at step intervals with 6- $\mu$ m sections for light microscopic evaluation. These were stained with hematoxylin and eosin and examined for external resorption (Howship's lacunae and clast-type cells) of cementum and dentin. Also evaluated was ankylosis (fusion of bone and dentin).

In both groups (extracted and block-removed), those teeth which exhibited resorption were identified as to the different bleaching procedures performed.

## RESULTS

Control group teeth did not demonstrate cervical resorption. However, with visual (stereomicroscopic) and histological examinations, 5 of the 30 teeth in the experimental groups that included root canal treatment and thermocatalytic bleaching showed significant resorptive defects. Some resorption areas also had superimposition of ankylosis. The specifics follow: *Radiographic*—Root resorption was not observed radiographically in any of the control or experimental treatment groups. *Histological*—Control teeth, i.e. those five with no treatment or the five with the root canal treatment alone without etching or bleaching, showed no evidence of external cervical root resorption (Fig. 1).

The majority of the experimental teeth, that is those with various bleaching procedures, had no evidence of external cervical resorption. In the group of 10 teeth with walking bleach only, no resorptive defects were noted histologically. In the teeth which were examined histologically only, two teeth with root canal treatment plus thermocatalytic bleaching demonstrated resorption/ankylosis in the cervical area (Figs. 2 to 4). Of the two, one tooth was from the group with etch/

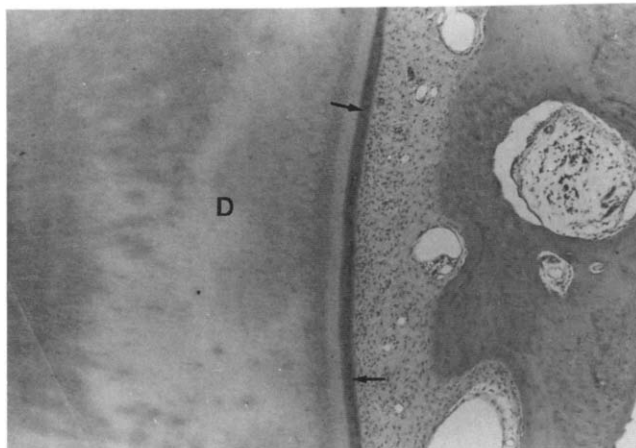


FIG 1. Histological section from control tooth (root canal treated without bleaching). The dentin (D) and cementum (arrows) along the external root surface are intact with no evidence of resorption (H & E; original magnification  $\times 90$ ).

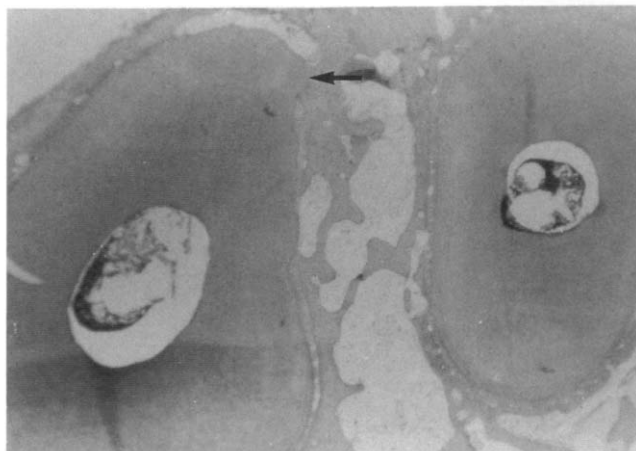


FIG 2. Approximating root canal-treated teeth, 1-yr posttreatment. The tooth on the right had walking bleach only and shows no resorption. That on the left was internally etched followed by heat plus 30% H<sub>2</sub>O<sub>2</sub>. Note the area of ankylosis in the region of the arrow. (H & E; original magnification  $\times 30$ ).

combination bleaching; the other was no etch with thermocatalytic bleaching.

*Stereomicroscopic Surface Examination*—Approximately one-third of the teeth had surface defects in the cervical areas of the roots. Many areas proved to be small surface imperfections which, upon histological examination, were not representative of resorption. There were others with larger defects showing significant loss of tooth structure. Of these, one tooth showing resorption was from the group no etch/thermocatalytic, two others were etched/combination bleached (Figs. 6 to 9).

## DISCUSSION

It was interesting that resorptive defects were not seen on radiographs, either immediate posttreatment or at the 1-yr observation. However, precise comparisons were difficult due to problems in film placement, reproduction, clarity, and inability to readily visualize interdental cervical regions be-

cause of overlapping of teeth. However, even without comparisons, no evidence of cervical root resorption was seen on the 1-yr follow-up films. In humans, radiographs may give more accurate information since reproduction and film quality for anterior teeth are more easily accomplished.

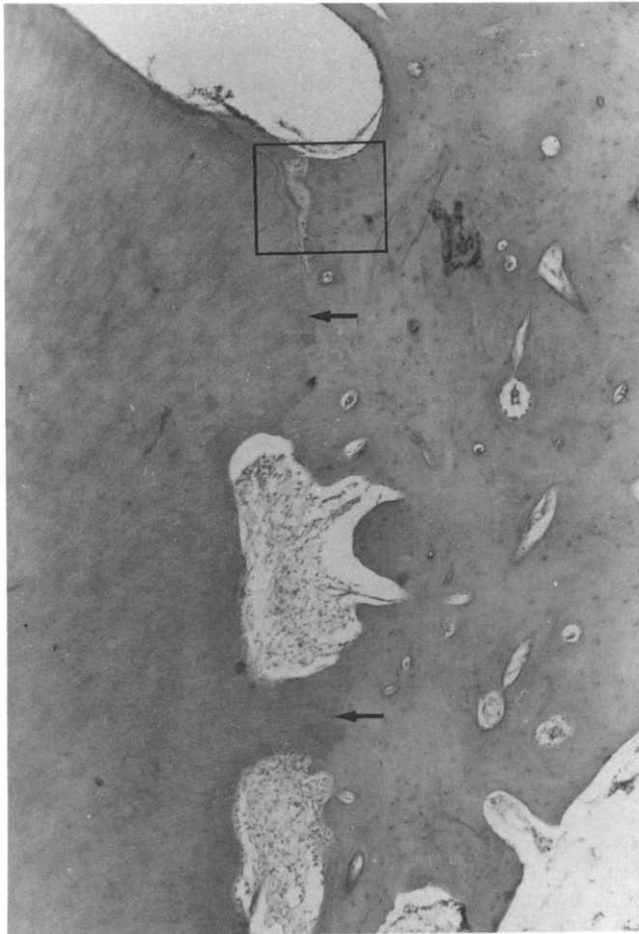


FIG 3. A different section of the left tooth in Fig. 2 in the region of the arrow. The continuous bone-dentin interface is evident in two areas (arrows) along the root surface (H & E; original magnification  $\times 90$ ).

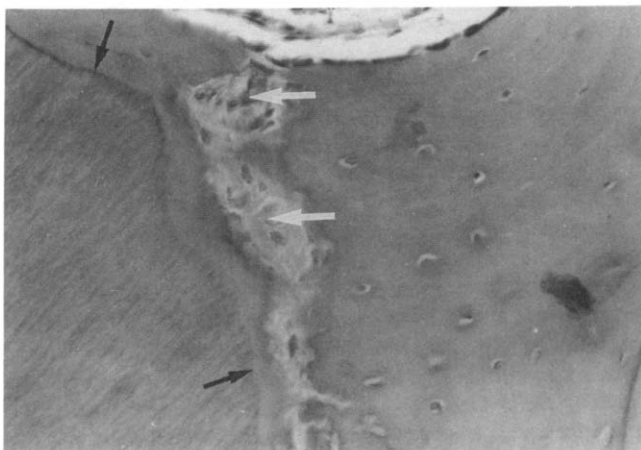


FIG 4. Area of box in Fig. 3. Note the area of prior resorption followed by apposition/ankylosis (black arrows) and connective tissue inclusions (white arrows) in the proximal bone. No definitive clast cells are identified, although resorptive activity likely was present earlier.

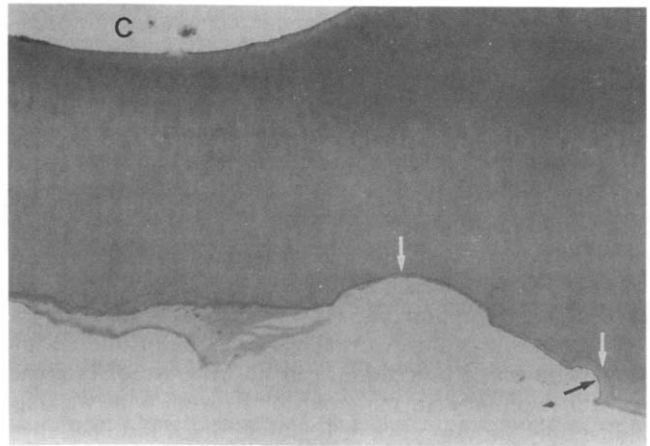


FIG 5. Cervical resorptive defect (arrow) with fragment of bone (B) attached to the specimen. This tooth was unetched and thermocatalytically (heat +  $H_2O_2$ ) bleached.

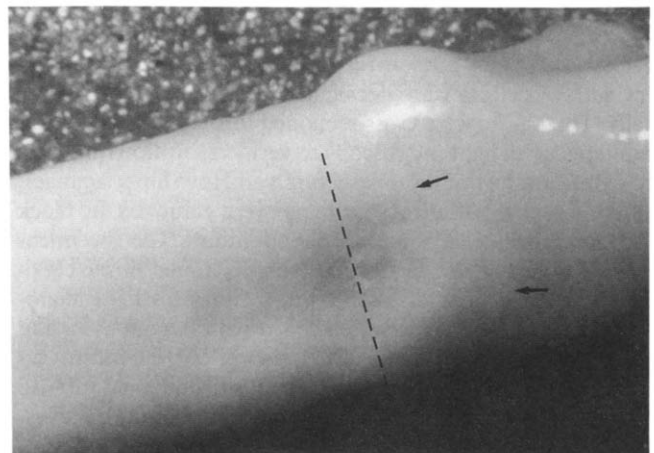


FIG 6. Proximal root surface in the cervical third of a root canal-treated tooth which was internally etched and the combination bleaching technique used. Arrows denote cemento-enamel junction. Note the elliptical, resorptive effect with increasing loss of tooth structure toward the center.

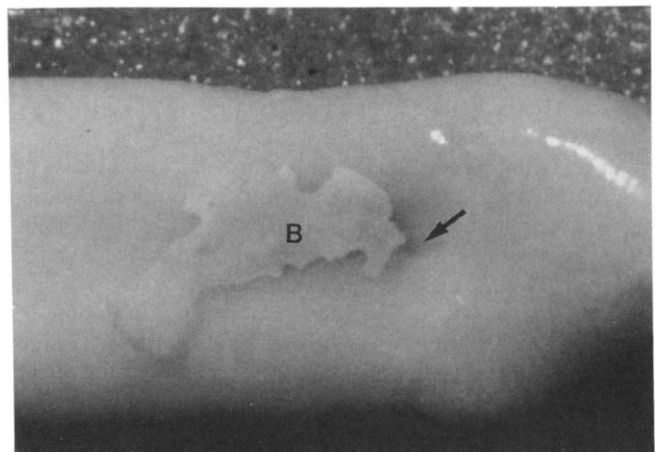


FIG 7. Histological cross-section through canal (C) and defect as shown by dashed line in Fig. 6. Note areas of resorption (white arrows) and reapposition (black arrow) (H & E; original magnification  $\times 100$ ).



FIG 8. Root canal-treated tooth, etched with combination bleaching. The cervical area demonstrates extensive resorption.

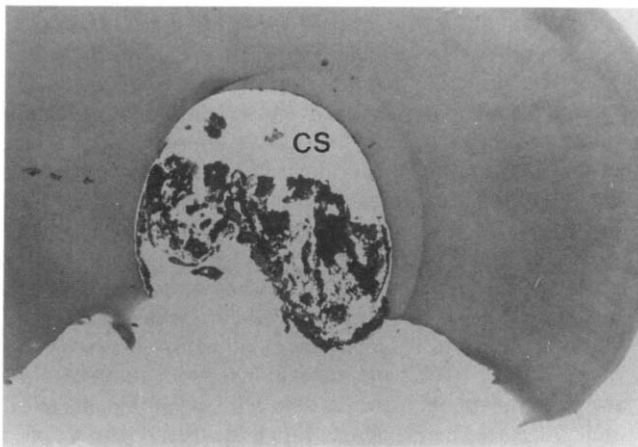


FIG 9. Histological section through the defect shown in Fig. 8 illustrates the depth and invasiveness of the resorption into the canal space (CS) (H & E; original magnification  $\times 50$ ).

From the results of this study, heat plus 30%  $H_2O_2$  was the combination associated with resorption. We were, however, unable to identify a *single* factor which may contribute to the initiation of external root resorption. Etching alone apparently is not responsible for the resorptive process, since resorption was present in both the etched and unetched experimental groups but was *not* observed in the root canal-treated

teeth which were etched only and not bleached. This study did not include groups in which heat or 30%  $H_2O_2$  was used alone, therefore we were unable to determine whether only *one* of these factors was the etiology.

It is unlikely that only heat would precipitate resorption. Heat is produced or introduced into canals commonly during removal of gutta-percha by very hot pluggers or by rotary instruments (13). If heat damage alone were a causative factor, resorption would occur frequently following such procedures; it does not. Also, 30%  $H_2O_2$  alone is an unlikely culprit. This chemical was mixed with sodium perborate for the walking bleach and presumably would be released into the dentin. However, when heat and  $H_2O_2$  were used in combination, resorption was induced in a few cases. The mechanism leading to resorption might be that the heat drives the highly caustic  $H_2O_2$  through tubules to chemically alter the cementum, rendering it a foreign substance. The end result would be similar to resorption that frequently follows avulsion/replantation or severe luxation injuries. The root surface is damaged by the trauma and/or loss of vitality of the periodontal ligament and cementum. By unknown mechanisms, resorption with or without ankylosis frequently is the result (14).

Our findings of resorption in teeth without trauma are in agreement with those reported by Friedman et al. (15). They evaluated patients following root canal treatment and bleaching also without history of trauma to the teeth. These authors found cervical root resorption in teeth bleached using a combination of thermocatalytic and walking bleach techniques.

The clinical applicability of our study has limitations in that the animal model used differs somewhat from humans, particularly regarding root dimensions. Specifically, the distance between the pulp canal and periodontal ligament is less in a dog than in a human; this could allow for more rapid penetration of the chemical agents and/or heat transfer to the periodontal ligaments. In addition, the tubular arrangement in dog teeth may differ as far as the extent of the tubules relative to the cementodentinal junction. Therefore, the effects of bleaching in this model may be more exaggerated than those seen in humans. However, there are similarities sufficient to verify that this is the same phenomenon as noted in case reports (7-12).

Interestingly, and to further amplify the comment that dentin thickness may be a factor, there was a tendency to see resorption on surfaces which were associated with the least dentin bulk between prepared canal space and periodontium.

Although the numbers of experimental teeth with resorption were relatively small, these are significant clinically. Because cervical resorption can be so devastating, even a small percentage is unacceptable if the resorption is preventable. Apparently, the more damaging factors, i.e. caustic 30%  $H_2O_2$  in combination with destructive heat, were the likely initiators. These should be avoided, particularly if other, more innocuous procedures will give similar results. Freccia et al. (6) showed that a sodium perborate/ $H_2O_2$  paste was as effective in bleaching as thermocatalytic or combination techniques. Even 30%  $H_2O_2$  could be eliminated at least in the initial bleaching attempts. Recommended is the use of walking bleach, with the sodium perborate mixed with water, saline, or anesthetic solution; this often is as effective as 30%  $H_2O_2$  (16).

Another safety measure would be to prevent chemicals from contacting tubules that communicate with the cervical

periodontium. The bleaching procedures and chemicals should be confined to the supragingival chamber.

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