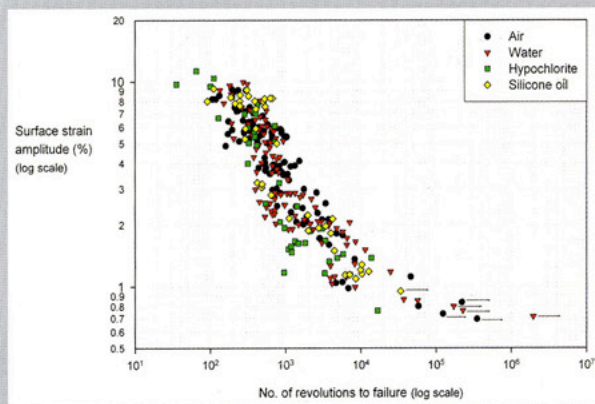


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A Six Year Evaluation of Cracked Teeth Diagnosed with Reversible Pulpitis: Treatment and Prognosis

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Abstract

The purpose of this investigation was to report on the clinical outcomes of cracked teeth diagnosed with reversible pulpitis (RP). Eight thousand one hundred seventy-five patients referred for evaluation and treatment during a 6-year period had medical and dental histories, radiographs, pulpal and periapical diagnosis, periodontal probings, direct identification of crack(s) with transillumination, and biting responses on various cusps recorded. All data were stored daily in a database. All cases were treatment planned according to the pulpal and periapical diagnosis. Cases with RP were treatment planned for crowns only, regardless of periapical diagnosis. All patients were recalled at 1 year unless root canal treatment was needed before the anniversary. Results indicated that cracks were identified in 9.7% (796 of 8175) of all teeth evaluated during this time period. Of 127 patients specifically diagnosed with RP, 27 converted to irreversible pulpitis (N = 21) in 58 days or to necrotic pulp (N = 6) in 149 days. To date, none of the original remaining 100 cases of RP have required root canal treatment. The outcomes of this study suggest that if a marginal ridge crack is identified early enough in teeth with a diagnosis of RP and a crown is placed, root canal treatment will be necessary in about 20% of these cases within a 6-month period. (*J Endod* 2007;33:1405–1407)

Key Words

Cracked teeth, reversible pulpitis

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The Fall/Winter 1997 AAE Colleagues for Excellence article entitled “Cracking the Cracked Tooth Code” (<http://www.aae.org/NR/rdonlyres/7D73B05C-FEE4-4B00-AB37-086056F163BC/0/fw97ecfe.pdf>) defined 5 types of tooth cracks. Four of the 5 cracks are associated with coronal defects generated from chewing and biting events (1). Teeth with craze lines have no pain, show lines in the enamel, but no “shadows” in the dentin with transillumination. Teeth with fractured cusps have mild pain to biting on a specific cusp, usually a marginal ridge and buccal or lingual groove crack in the dentin, seen as a shadow with transillumination and a Class II restoration. Removal of the restoration might result in the cusp breaking off. Cracked teeth might or might not have a restoration, will exhibit acute pain on mastication, early brief pain to cold, centrally located mesial-to-distal marginal ridge crack(s) seen in the dentin as a shadow(s) with transillumination, normal-to-deep periodontal probings associated with the crack, no detectable movement of cusps with an explorer, and might require removal of existing restorations to definitively diagnose. The pulpal and periapical diagnoses are dependent on the extent of the crack and duration of the symptoms. Split teeth usually have marked pain to chewing, can be considered an extension of the cracked tooth, have mesiodistal cracks extending across both marginal ridges with detectable buccal and lingual cusp separation with an explorer, and deep probings with both marginal ridges. Vertical root fractures begin in the roots of teeth that usually have had endodontic treatment, extend in the buccal-to-lingual plane, usually have minimal signs or symptoms, might have normal probings, and require surgical assessment to complete the diagnosis.

The treatment of teeth diagnosed as a cracked tooth has largely been variable and empirical. The Fall/Winter 1997 AAE Colleagues for Excellence article entitled “Cracking the Cracked Tooth Code” suggested “the treatment plan will vary depending on the location and extent of the crack” and noted that “any thermal sensitivity probably indicates the crack extends near or into the pulp, and root canal treatment will be necessary prior to restoring the tooth with a crown” (1). The juxtaposition to assuming the tooth will need root canal treatment before the crown is to place the crown first, see whether symptoms subside, and only perform root canal treatment when the pulpal and periradicular status dictates treatment. Ailor (2) presented a “flow chart” that took into consideration the pulp status at the time of discovery of the crack. He suggested temporizing the tooth with a temporary crown and monitoring it for symptoms.

Incidence data from Hiatt (3) and Cameron (4) found that the most frequently involved teeth were mandibular molars followed by maxillary premolars and then by maxillary first molars. Weine et al (5) found that the most frequently involved teeth were mandibular molars followed by maxillary molars and then by maxillary premolars.

To date there have been no studies that have looked at teeth diagnosed with cracks (cracked teeth) that have a pulpal diagnosis of reversible pulpitis (RP) and are subsequently crowned without initial root canal treatment. The purpose of this investigation was to report on the clinical outcomes of cracked teeth that were initially diagnosed with RP that were crowned during a 6-year period. Specific questions to be answered were the following: (1) what are the locations of these cracked teeth in the mouth? (2) What is the periodontal status of these cracked teeth? (3) Where are the cracks located on the teeth? (4) How many teeth required root canal therapy? (5) What clinical changes occurred in or around the teeth requiring root canal therapy?

Clinical Research

TABLE 1. The Number and Percentage of Cracked Teeth by Tooth Position in the Mouth

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	71	167	46	25	243	231	12	1	796
Total	835	1879	754	549	1380	2100	456	222	8175
%	8.50	8.89	6.10	4.55	17.61	11.00	2.63	0.45	9.74

Materials and Methods

There were 8175 patients included in this study from a private endodontic practice population during a 6-year period. The patients were recorded consecutively as they were referred to the endodontist for evaluation and appropriate treatment during the 6-year period. Besides the standard medical history and subjective history, the endodontist was responsible for the diagnosis of all teeth and recorded the following information for all teeth:

- (1) Pulpal response to cold or hot.
- (2) Periapical response to pressure, palpation, and percussion.
- (3) Buccal and lingual periodontal probings were recorded in the mesial and distal interproximal spaces and furca. These interproximal probings would be directed precisely where marginal ridge cracks were identified to indicate the deepest probing of the crack. A total of 6 probing points were recorded for each tooth.
- (4) Identification of a crack(s) with direct transillumination and visualization with and without magnification. The identified crack had to block light transmission and show a definite shadow with both the buccal and lingual coronal light placement. Teeth not exhibiting a shadow were considered to have "crazings" and were not included in this study.
- (5) Responses to biting on various cusps of the diagnosed tooth, with at least 1 cusp exhibiting pain to biting on either a burlew wheel or Tooth Slooth (Professional Results, Inc, Laguna Niguel, CA).

Teeth were diagnosed with RP if (1) there was no history of spontaneous pain; (2) the response to cold went away in less than 3–5 seconds; (3) there was no radiographic pathosis.

No teeth were included in this part of the study that could not be confirmed by visualization as having an identifiable crack even if biting sensitivity was present. Restorations were removed only for patients with pulpal diagnoses that required root canal treatment. Teeth diagnosed as cusp fractures, split teeth, and vertical root fractures were also excluded from this study (6). All patients were recalled at 1 year unless root canal treatment was needed before the anniversary; then recall was 1 year later after treatment. The recall therefore extended into a seventh year of the data collection.

All cases were treatment planned according to the pulpal and periapical diagnosis. Cases with RP were treatment planned for crowns only, regardless of periapical diagnosis.

Results

Of the 8175 cases seen during the 6-year period, 796 cases were diagnosed as cracked teeth (9.7%). Mandibular second molars (243/796, 30%) had the largest incidence followed by mandibular first molars (231/796, 29%) and maxillary first molars (167/796, 21%). All teeth are included in Table 1.

Cases with RP had the following distribution: mandibular first molars (41/127, 32%), maxillary first molars (33/127, 25%), and mandibular second molars (29/127, 23%). All teeth are included in Table 2.

Of 127 patients specifically diagnosed with RP, 27 converted to irreversible pulpitis (N = 21) in 58 days or to necrotic pulp (N = 6) in 149 days. The distribution of teeth requiring root canal therapy was as follows: maxillary first molars (9/27, 33%), mandibular second molars (8/27, 29%), mandibular first molars (7/27, 26%), and maxillary second molars (3/27, 11%).

All teeth had initial interproximal probings less than 3 mm in the space associated with the identified crack. Increased interproximal probings were associated with the fractured marginal ridge for only 5 of the 27 teeth requiring root canal treatment. The greatest increase in probing depth was 2 mm for 2 of 5 teeth.

The teeth requiring root canal treatment had the crack located on the distal marginal ridge in 15 of the 27 cases (56%). The distribution was mandibular second molars (6/27, 27%), mandibular first molars (3/27, 11%), maxillary first molars (3/27, 11%), maxillary second premolars (2/27, 7%), and maxillary second molars (1/27, 4%). The crack was located only on the mesial marginal ridge in 4 of the 27 cases (15%). The distribution was the maxillary first molars (3/27, 11%) and maxillary first premolars (1/27, 4%). Both marginal ridges were involved in 8 of the 27 cases (29%). The distribution was mandibular first molars (5/27, 19%), maxillary first molars (2/27, 7%), and maxillary second molars (1/27, 4%). None of the teeth had fractures that extended into the floor of the chamber or rendered them "non-restorable".

None of the original remaining 100 cases of RP required root canal treatment.

Discussion

The patients who composed this database were all patients referred to a private practice endodontist. Our incidence data are in agreement with the findings of Weine et al (5), which were also derived from an endodontist's practice. The difference in percentages from

TABLE 2. The Number and Percentage of Cracked Teeth by Tooth Position with RP Eventually Requiring Root Canal Treatment

	Maxillary Second Molar	Maxillary First Molar	Maxillary Second Premolar	Maxillary First Premolar	Mandibular Second Molar	Mandibular First Molar	Mandibular Second Premolar	Mandibular First Premolar	Totals
Cracked	12	33	8	4	29	41	0	0	127
REV- > IP or NEC.	3	9			8	7			27
%	25	27	0	0	28	17			21

REV, reversible pulpitis; IP, irreversible pulpitis; NEC, necrosis.

other studies might be largely due to the nature of general dental populations versus an endodontic specialty population. Hiatt (3) and Cameron (4) reported maxillary premolars having the second highest incidence of cracks, which represents a periodontist and general dental practice. Therefore, this study's population might be under-represented with respect to premolars and the actual incidence of cracked teeth in the population at large.

This study found that 21% of the cases diagnosed with RP and a crack eventually required root canal treatment. Although no other studies have reported this finding, there have been studies examining the necessity for root canal treatment on teeth restored with crowns. Saunders and Saunders (7) reported that 19% of crowned teeth in a Scottish dental school population had root canal treatment after crown placement. This study was unable to report whether cracks were present before the crown was placed.

Cheung et al (8) found that 15% (19/122) of teeth restored with a ceramo-metallic crown required root canal treatment after crown placement in a population in Asia. They also found that of those serving as an abutment of a fixed-fixed bridge (25/77), 32% required root canal treatment after final cementation of the bridge.

Although the populations in these 2 studies are quite diverse, the similar percentages for teeth requiring root canal treatment after crown placement suggest that 15%–19% of their patients are to be expected for all crowns. The 21% of the cases in this study with RP and cracks that were crowned and subsequently required root canal treatment is only slightly higher than the 15%–19% and suggests similar incidence data.

When examining a tooth with both mesial and distal marginal ridge fractures, the natural assumption would be that more of these teeth

would eventually require root canal treatment. Our data showed more teeth with a single marginal ridge crack, either mesial or distal, eventually required root canal treatment. This underlines the difficulty in predicting the eventual need for root canal treatment in teeth with RP and a cracked marginal ridge.

Conclusions

The outcomes of this study suggest that if a crack is identified early enough in cases with a diagnosis of RP and a crown is placed, root canal treatment will be necessary in about 20% of these cases within a 6-month period. Progression of interproximal periodontal defects associated with the crack(s) will occur in a very small percentage of the cases (5/127, 4%).

References

1. Cracking the cracked tooth code. *Endodontics: Colleagues for Excellence 1997 (Fall/Winter)*:1–13.
2. Ailor JE Jr. Managing incomplete tooth fractures. *J Am Dent Assoc* 2000;131:1168–74.
3. Hiatt WH. Incomplete crown-root fracture in pulpal-periodontal disease. *J Periodontol* 1973;44:369–79.
4. Cameron CE. The cracked tooth syndrome: additional findings. *J Am Dent Assoc* 1976;93:971–5.
5. Weine FS, Dewberry Jr, James A. Cracked-tooth syndrome: vertical fractures of posterior teeth. In: Weine FS, ed. *Endodontic therapy*. 3rd ed. St Louis: Mosby, 1982:8–15.
6. Rivera EM, Walton RE. Longitudinal fractures. In: Torabinejad M, Walton RE, eds. *Principles and practice of endodontics*. 4th ed. Philadelphia: Saunders, in press.
7. Saunders WP, Saunders EM. Prevalence of periradicular periodontitis associated with crowned teeth in an adult Scottish subpopulation. *Br Dent J* 1998;185:137–40.
8. Cheung GS, Lai SC, Ng RP. Fate of vital pulps beneath a metal-ceramic crown or a bridge retainer. *Int Endod J* 2005;38:521–30.