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# UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES

POSTGRADUATE DENTAL COLLEGE  
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## THESIS APPROVAL PAGE FOR MASTER OF SCIENCE IN ORAL BIOLOGY

Title of Thesis: Outcome of Endodontically Treated Cracked Teeth

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Master of Science Degree  
June 01, 2022

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OUTCOME OF ENDODONTICALLY TREATED CRACKED TEETH

by

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A thesis submitted to the Faculty of the  
Endodontics Graduate Program  
Naval Postgraduate Dental School  
Uniformed Services University of the Health Sciences  
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in Oral Biology  
June 2022

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## **DISCLAIMER**

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# ABSTRACT

## Outcome of Endodontically Treated Cracked Teeth

Tyler Jonathan Quinn, D.D.S., 2022

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**Introduction:** The incidence of cracked teeth is quite common. Symptoms include characteristic thermal sensitivity and pain on mastication. Treatment of choice is a full coverage restoration, however if pulpal and/or periapical disease is identified, non-surgical root canal treatment (NSRCT) is necessitated. The purpose of this study is to determine outcomes of endodontically treated cracked teeth over five years. **Methods:** This observational study enrolled prospective and retrospective patients who had a diagnosis of cracked tooth and underwent endodontic therapy. Patients were recalled every year for up to five years. **Results:** This interim analysis included 151 human subjects enrolled (n=152 teeth), of which 65% were found to be healed (lack of clinical symptoms and radiographic lesion) and 80% were found to be functional (lack of clinical symptoms only) at one-year. **Conclusion:** Favorable outcomes were observed in endodontically treated cracked teeth and predictable outcomes can be expected.

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## LIST OF ABBREVIATIONS

AAE	American Association of Endodontists
CI	confidence interval
NPDS	Naval Postgraduate Dental School
NSRCT	non-surgical root canal treatment
PAI	periapical index
PARL	periapical radiolucency

## CHAPTER 1: Introduction

The American Association of Endodontics (AAE) defines a cracked tooth as “a thin surface disruption of enamel and dentin, and possibly cementum, of unknown depth or extension” (1). While the aforementioned definition was updated in 2015 by the AAE Special Committee on Cracked Tooth Initiative and is currently included in the 2020 publication of the AAE Glossary of Endodontic Terms, in no way are cracked teeth a new area of study. In 1954 Gibbs first described an “incomplete fracture into dentin or even pulp” (2). He noticed an increasing trend in teeth that have pain on mastication but are otherwise asymptomatic and proposed the diagnostic term “cuspal fracture odontalgia” (2).

In 1964, Cameron is credited for coining the phrase “cracked tooth syndrome”, commonly used by diagnosticians today (3). Cameron noticed two trends in his patients. First, patients would present with pain to pressure or cold. This pain would persist after occlusal adjustments until finally a cusp broke off and all symptoms were alleviated. He postulated the tooth had an undiagnosed fracture from initial symptom onset. Second, seemingly healthy teeth (small restorations and no periodontal disease) presented with abscesses. Upon extraction and examination, cracks were noted extending into the cementum which could act as an avenue for bacteria to infect the pulp. Cameron described three patients with cracked teeth and upon receiving full cuspal coverage restorations the symptoms subsided (3). This provided the basis for his research and treatment recommendations. The most important factor in the diagnosis of cracked teeth is awareness of the symptoms (3, 4).

Cracked teeth often present with vague symptoms which can often be difficult to reproduce (5). This poses numerous concerns to not only the patient but the practitioner as well. From the patient's perspective, thermal and mastication pain may be present for years without diagnosis. For the clinician, the symptoms are frequently difficult to reproduce and erroneous treatment may be rendered without proper diagnosis (5).

In 2008 the AAE published a Colleagues for Excellence entitled "Cracking the Cracked Tooth Code: Detection and Treatment of Various Longitudinal Tooth Fractures" as a resource to define crack types and provide treatment planning recommendations. The publication advocates for clear communication between specialists and general practitioners (6). It identifies longitudinal tooth fractures as belonging to one of five categories: craze lines, split tooth, fractured cusp, vertical root fracture and cracked tooth. Rivera and Walton describe a cracked tooth as "an incomplete fracture initiated from the crown and extending subgingivally, usually directed mesiodistally" (6). Crack detection alone should not solely determine the treatment plan. Consideration for the pupal and periapical diagnosis should be included in treatment planning decisions.

Research regarding the diagnosis and treatment planning of cracked teeth is plentiful. However, few studies exist on the long-term outcomes of endodontic treatment on cracked teeth (7). There is only one retrospective study reporting five-year outcomes of endodontically treated cracked teeth (8). Furthermore, there are no prospective studies of a five-year duration (9). This outcome data is vital during the treatment planning discussion with patients in order to provide adequate informed consent. The purpose of this retrospective/prospective study is to determine the outcome of endodontically treated

cracked teeth annually for up to five years. A secondary aim was to identify associated variables that may affect the outcome.

## **CHAPTER 2: Materials and Methods**

\*This study, WRNMMC IRB #410603, “Outcome of Endodontically Treated Cracked Teeth”, is ongoing. The Material and Methods section for this paper was taken from the approved protocol (10).

This study retrospectively and prospectively collected data from subjects referred to the endodontic clinic at the Naval Postgraduate Dental School (NPDS). Inclusion criteria for the study included the following: the subject 1) was at least 18 years of age; 2) willingly provided consent; 3) was diagnosed with a cracked tooth at the NPDS endodontic clinic; 4) required endodontic treatment on the cracked tooth; and 5) all endodontic treatment was performed by a NPDS endodontic resident or faculty member.

A thorough pre-operative radiographic and clinical examination was performed. Various methods were employed to aid in the diagnosis of a cracked tooth including direct visualization (with or without the use of magnification or a dental operating microscope), transillumination, methylene-blue dye application, and Tooth Slooth® bite test. For the prospective portion of the study, subjects were enrolled when a diagnosis of cracked tooth was made before the initiation of endodontic treatment or following the access preparation if a crack was noted. For the retrospective portion, subjects were enrolled if cracked tooth details were noted retrospectively in the patient’s record during a routine follow-up examination. An associate investigator obtained informed consent from the subject and all subjects were enrolled in the NPDS Endodontic Treatment Registry; WRNMMC #352271, a database of patients maintained in the NPDS Endodontic Department. The Endodontic Treatment Registry collects information on patient demographics, health history, initial exam findings, perioperative notes, and follow-up data. Additional cracked tooth

information was collected during the initial evaluation including tooth characteristics, diagnostic methods, and fracture location (see APPENDIX A, B, C, D). Following the collection of pre-treatment data, NSRCT was provided. Subjects with previously initiated therapy from other clinics (i.e. pulpotomy or pulpectomy) were excluded from this study. No specified instrumentation technique, irrigation technique, or obturation technique was required, and all were documented on standardized data forms (see APPENDIX E). Teeth were accessed using rubber dam isolation; information regarding crack location and extent was collected after access (see APPENDIX C). Following completion of treatment and temporization, subjects were referred for the definitive restoration of the tooth. At a minimum of twelve months after the endodontic treatment, subjects returned for a follow-up clinical and radiographic examination (see APPENDIX F). Each year following treatment, subjects were asked to return for subsequent follow-up examinations with data collection for up to five years.

Assessment of the clinical and radiographic data determined the outcome. The clinical examination included percussion, palpation, periodontal probing, mobility, and sensibility testing. The radiographic examination included one periapical radiograph at a minimum. Three calibrated, board-certified endodontists individually assessed the randomized immediate post-treatment and most recent follow-up radiographs on a shared laptop with image enhancement capabilities using the Periapical Index (PAI) (11). A dichotomous classification system of healed or non-healed was used for each tooth. A tooth was considered healed if the following criteria were met: 1) the tooth was asymptomatic (no pain, mobility, swelling, sinus tract, percussion sensitivity, and palpation sensitivity) and 2) the PAI score was 1 or 2. A tooth was considered non-healed if: 1) the

tooth presented with symptoms or 2) the PAI score was 4, or 5. Teeth designated a PAI score of 3 were excluded from both the healed, and non-healed categories unless clinical symptoms were present, in which case the tooth was diagnosed as non-healed. In a separate analysis, all asymptomatic teeth, regardless of PAI score, were considered functional (clinical success) and all present (non-extracted) teeth regardless of symptoms were considered survived.

Extraction-free survival probabilities over five year follow up were estimated using the Kaplan-Meier method, which accounts for the censoring of observations, or incompletely observed survival times over follow up, by calculating survival to a given time point as the product of conditional probabilities for intervals of available observation times (e.g., the probability of surviving for four years is the probability of surviving for three years times the probability of surviving four years given that the third year was survived). Separate analyses were performed among evaluated teeth at each follow up to estimate the annual frequencies of healed and functional outcomes and their 95% binomial confidence intervals. Additionally, to evaluate for potential predictors of these outcomes, demographic and clinical characteristics were compared by healed and functional status at 1 year follow up and compared using t-tests or Fisher's exact tests. R statistical software was utilized to complete data analysis (Vienna, Austria).

Based on previously published literature, an expected healed rate of 70% with a desired 95% confidence interval of +/- 10% for the precision of the estimated healed rate produced the need for 93 subjects with 5 year follow ups for analysis. Those assumptions and a 5-year recall rate assumed at 45% were used to perform power analysis giving a target sample size of 250 subjects.

## **CHAPTER 3: Results**

This interim analysis included both retrospective and prospective data. The retrospective portion of the study is closed as of this analysis, and the five-year recall data is included. 158 teeth from 151 subjects were enrolled in the study. 6 patients were identified as “ineligible” and were excluded leaving 152 teeth available for the extraction (survivability) analysis cohort. Furthermore, when calculating data for healed and functional rates, teeth that were not yet eligible for a follow-up appointment or teeth that had been extracted were excluded from the analysis.

### **EXTRACTION / SURVIVAL ANALYSIS**

If a tooth was present at recall a tooth is considered survived despite clinical or radiographic signs or symptoms. The cumulative 5-year survival, or the estimated survival to 5 years for a member of the studied population, was 82% (95% CI 73-91%). The blue shaded area is the confidence interval and expands as it gets closer to five years. (Fig. 1). The number at risk indicates patients whose data was available for at a given time point.

### **HEALED AND FUNCTIONAL ANALYSES**

In calculating healed and functional rates 106 subjects completed a one-year recall (80.1% recall rate), 69 completed a two-year recall (61.2% recall rate), 46 completed a three-year recall (54.0% recall rate), 26 completed a four-year recall (40.6% recall rate), and 11 completed a five-year recall (31.4% recall rate).

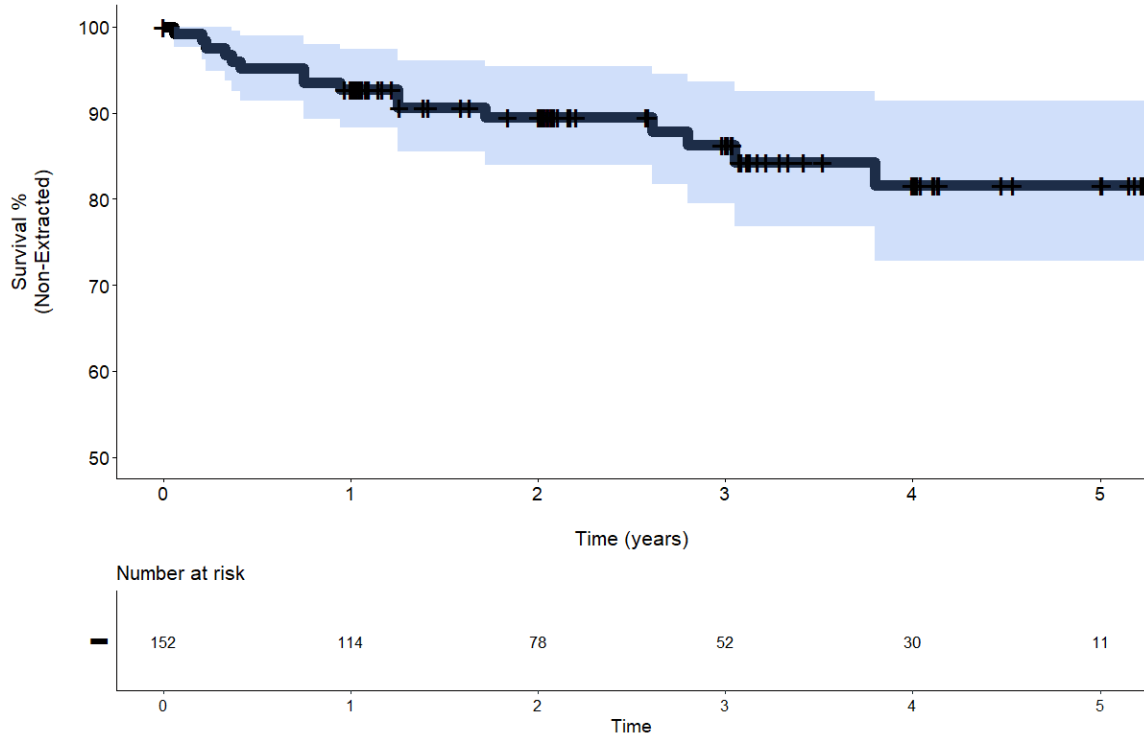
At one-year, 80% of teeth were functional (95% CI 72-87%) and 65% of teeth were healed (95% CI 56-74%) (Fig. 1). The functional and healed rates for years two through five are: 87% (95% CI 77-93%), 67% (95% CI 55-77%) (two-year); 87% (95% CI 74-

94%), 67% (95% CI 53-79%) (three-year); 88% (95% CI 70-97%), 77% (95% CI 58-89%) (four-year); and 100% (95% CI 70-100%), 91% (95% CI 60-100%) (five-year). Healed and functional rates are reported (Table 1, Fig. 2).

#### **DEMOGRAPHICS AND CO-VARIATES**

The mean follow-up time is 2.0 years (SD 1.6 years). 70% were male and 30% were female with ages ranging from 21-83 years old with a mean age of 49 years. The most frequent tooth to exhibit a crack were mandibular second molars (37.5%) followed by the mandibular first molars (27%) (Table 2). The majority of cracked teeth were in a non-terminal position (55.3%) when compared to a terminal position (44.7%).

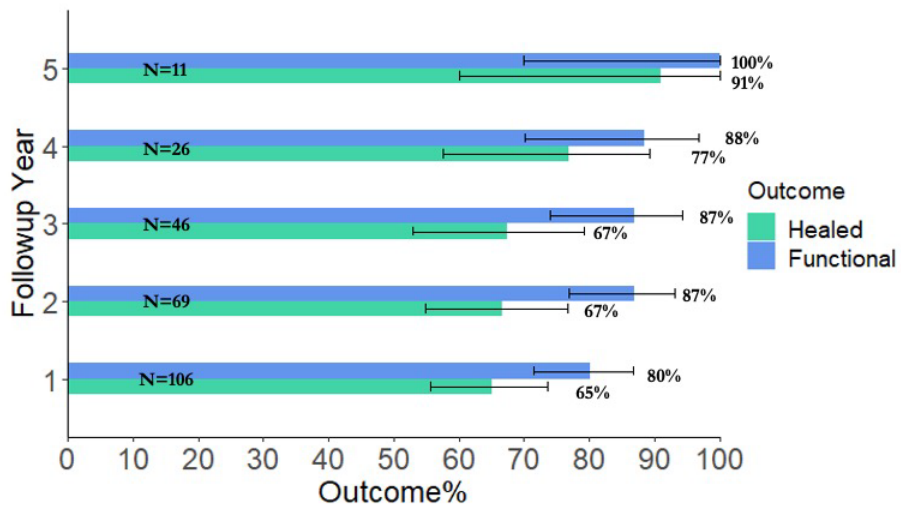
At this time the presence of a post was negatively associated with healed outcomes and is the only covariate of significance (Table 3b).



**Figure 1.** The figure shows the estimated proportion surviving (were not extracted) on the y-axis by any given time, shown on the x-axis. The cumulative 5-year survival was 82% (95% CI 73-91%).

**Table 1.** The 5-year healing and functional trend results, expressed as a percentage.

<b>Follow-up Year</b>	<b>Healed</b>	<b>Functional</b>
<b>1</b>	65%	80%
<b>2</b>	67%	87%
<b>3</b>	67%	87%
<b>4</b>	77%	88%
<b>5</b>	91%	100%



**Figure 2.** A horizontal bar graph depicting the outcomes at years 1-5 as either healed (green), or functional (blue). Error bars represent 95% confidence intervals.

**Table 2:** The incidence of a crack for a particular tooth type expressed as a percentage, as well as the number of subjects.

<b>Tooth Type</b>	<b>Incidence</b>
<b>Mandibular 2<sup>nd</sup> Molar</b>	37.5%
<b>Mandibular 1<sup>st</sup> Molar</b>	27%
<b>Maxillary 1<sup>st</sup> Molar</b>	17.1%
<b>Maxillary 2<sup>nd</sup> Molar</b>	9.2%
<b>Maxillary 2<sup>nd</sup> Premolar</b>	4.6%
<b>Mandibular 2<sup>nd</sup> Premolar</b>	2.0%
<b>Maxillary 1<sup>st</sup> Premolar</b>	1.3%
<b>Mandibular 3<sup>rd</sup> molar</b>	0.7%
<b>Maxillary Canine</b>	0.7%

**Table 3a:** Characteristics by functional status at follow-up year 1.

	Not Functional N=21	Functional N=85	P value
Age	54.3 (12.2)	49.9 (11.5)	0.14
<b>Gender:</b>			
Female	5 (19.2%)	21 (80.8%)	1.00
Male	16 (20.0%)	64 (80.0%)	
<b>Enrollment type:</b>			
Prospective	20 (20.8%)	76 (79.2%)	0.68
Retrospective	1 (10.0%)	9 (90.0%)	
<b>Pre-Operative Cold Sensitivity:</b>			
NR	6 (12.5%)	42 (87.5%)	0.14
R/L	9 (22.5%)	31 (77.5%)	
R/NL	6 (33.3%)	12 (66.7%)	
<b>Pre-Operative Radiolucency:</b>			
No	9 (18.8%)	39 (81.2%)	1.00
Yes	9 (17.3%)	43 (82.7%)	
Pre-Operative Pain	4.00 (3.13)	3.44 (3.13)	0.47
<b>Pulpal Status:</b>			
Vital	14 (22.2%)	49 (77.8%)	0.61
Necrotic	7 (16.3%)	36 (83.7%)	
<b>Permanent Restoration at Follow-up:</b>			
No	4 (44.4%)	5 (55.6%)	0.08
Yes	17 (17.9%)	78 (82.1%)	
<b>Intracanal Post Present at Follow-up:</b>			
No	17 (17.3%)	81 (82.7%)	0.08
Yes	3 (50.0%)	3 (50.0%)	
P values are from t-tests for continuous variables and Chi-square or Fisher's exact tests for categorical variables.			

**Table 3b:** Characteristics by healed status at follow-up year 1.

	Healed N=69	Unhealed N=37	P value
Age	50.8 (11.2)	50.6 (12.7)	0.92
<b>Gender:</b>			
Female	17 (65.4%)	9 (34.6%)	1.00
Male	52 (65.0%)	28 (35.0%)	
<b>Enrollment type:</b>			
Prospective	63 (65.6%)	33 (34.4%)	0.74
Retrospective	6 (60.0%)	4 (40.0%)	
<b>Pre-Operative Cold Sensitivity:</b>			
NR	32 (66.7%)	16 (33.3%)	0.92
R/L	26 (65.0%)	14 (35.0%)	
R/NL	11 (61.1%)	7 (38.9%)	
<b>Pre-Operative Radiolucency:</b>			
No	35 (72.9%)	13 (27.1%)	0.23
Yes	31 (59.6%)	21 (40.4%)	
Pre-Operative Pain	3.75 (3.15)	3.19 (3.07)	0.38
<b>Pulpal Staus:</b>			
Vital	42 (66.7%)	21 (33.3%)	0.84
Necrotic	27 (62.8%)	16 (37.2%)	
<b>Permanent Restoration at Follow-up:</b>			
No	4 (44.4%)	5 (55.6%)	0.28
Yes	63 (66.3%)	32 (33.7%)	
<b>Intracanal Post Present at Follow-up:</b>			
No	67 (68.4%)	31 (31.6%)	0.02
Yes	1 (16.7%)	5 (83.3%)	
P values are from t-tests for continuous variables and Chi-square or Fisher's exact tests for categorical variables.			

## CHAPTER 4: Discussion

In this study teeth were considered healed if clinical signs and symptoms were absent and a PAI score of 1 or 2 was determined. This healed rate of 65% at one-year is significantly lower than other similar studies. In 2018, Krell and Caplan reported a one-year success rate of 82%. They did not define specific signs or symptoms that indicated success versus failure (12). Similarly, Olivieri and Elmsmari reported an 82% success rate in their systematic review and meta-analysis (9). The lower success rate of the present study could be due to the strict radiographic and clinical criteria used to evaluate healed teeth.

The two-year healed rate for this study is 67%. This is similar to a study published by Chen and Hsu in 2021 who reported a 75.8% success rate with an average of 23.3 month follow-up (13). Additionally, they found cracked teeth treated with endodontic therapy and received full-coverage restorations had a 93.6% two-year success rate, compared to those without (20% success rate). Success rates were decreased with the presence of a periapical radiolucency (PARL), a post, and a deep probing depth (13). Our secondary analysis of prognostic factors related to endodontically treated cracked teeth in this study identifies the presence of a post as the only negative prognostic factor for healing. As the sample size grows to the target number of 250 and more recall appointments are performed, data should be available for a more robust covariate analysis.

A five-year survivability probability was determined to be 81.6% (95% CI 72.8%, 91.4%). The only other study that reports a five-year survival rate is retrospective. This study evaluated eighty-four patients with a five-year survival rate of 92% (8). The five-year survival rate in the present study is significantly lower.

The most commonly cracked tooth in the present study is the mandibular 2<sup>nd</sup> molar (37.5%), followed by the mandibular 1<sup>st</sup> molar (27%) (Table 2) which is consistent with previously published findings (7, 14, 15). A tendency exists for the terminal teeth to have a higher incidence of cracks (9). This trend can be explained by the physics of the temporomandibular joint, where a higher amount of force is applied closer to the point of joint articulation. This study, consistent with previously published studies, demonstrates molars having a higher incidence of cracks than premolars (12, 16).

Limitations to this study exist mainly in the nature of the patient population. Subjects included were primarily active-duty service members, their family members, and retirees. This population is highly migratory as duty station transfers occur roughly every 2-3 years. This can be noted in the decreasing recall rates overtime. Estimates of healed and functional rates among those who completed annual recalls may be subject to selection bias, in which completers were generally younger at enrollment relative to non-completers. Additionally, this study began in 2015 and data collection has occurred over the course of 7 years. While PAI scoring was completed by three Board Certified Endodontists, these reviewers were not the same over the course of the study. Previous research has demonstrated agreement between radiographic examiners to be less than 50% (17).

Similarly, enrollments and follow-up data were obtained by endodontic residents who varied year by year. This introduces potential for varying techniques on measuring percussion, palpation, and probing depths which affects healed and functional rates.

## **CHAPTER 5: Conclusions**

152 teeth were included in this prospective and retrospective analysis on endodontically treated cracked teeth. A one-year healed rate is reported at 65%, with a higher functional rate at 80%. There is an increasing trend toward healing and functionality over time. An 82% five-year survivability probability is estimated. High functional and survival rates indicate cracked teeth requiring endodontic treatment can be reliably retained over five years.



# APPENDIX B

## Cracked Tooth Pre-Operative Data Form

Subject# \_\_\_\_\_

### Visualization of Cracks in Tooth Pre-Treatment (at Evaluation)

Tooth number \_\_\_\_\_

Check the appropriate boxes/fill in blanks

Please fill in probing depths (mm)

	M	Mid	D
B			
L			

Date: \_\_\_\_\_

Did you visualize a crack at examination (Circle one)?

NO

YES



Location of Fracture  
(check all that apply)

- Mesial Marginal ridge
- Distal Marginal ridge
- Occlusal Surface
- Buccal Groove
- Lingual Groove
- Other \_\_\_\_\_

# APPENDIX C

## Cracked Tooth Access Data Form

Subject# \_\_\_\_\_

**Visualization upon endodontic ACCESS**

Tooth number \_\_\_\_\_

Check the Appropriate boxes/Fill in blanks

Please fill in probing depths (mm)

	M	Mid	D
B			
L			

Date: \_\_\_\_\_

Did you visualize a crack upon access (circle one)?

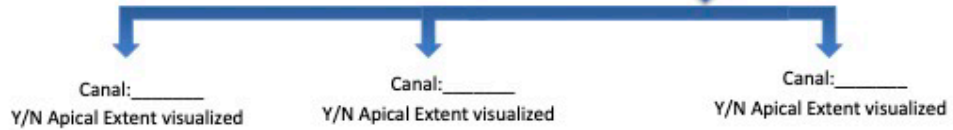
NO YES

Location of Fracture (check all that apply)

- Mesial Marginal ridge
- Distal Marginal ridge
- Axial Wall \_\_\_\_\_
- Floor of chamber
- Other \_\_\_\_\_

Did the crack enter a canal?

NO YES



# APPENDIX D

## Registry/Cracked Tooth Pre-Operative Data Form

Subject #: \_\_\_\_\_

**PROTOCOL #410603-REGISTRY/CRACKED TOOTH PREOPERATIVE DATA COLLECTION FORM**

Tooth type:                      single root    multiple root

Subject meets eligibility criteria (Y/N)

Does patient have any of the following conditions (circle):

Hypertension: B/P \_\_\_\_\_      Smoker      Coronary Heart Disease      Diabetes Type: \_\_\_\_\_

Symptoms:    Y/N

- |  |  |
|--|--|
| <input type="checkbox"/> Pain (0-10) (Y/N)<br><input type="checkbox"/> Can locate pain by quadrant (Y/N)<br><input type="checkbox"/> Can locate pain by tooth (Y/N)<br><input type="checkbox"/> Tooth #<br><input type="checkbox"/> /80 Electric pulp tester<br><input type="checkbox"/> Palpation sensitivity<br><input type="checkbox"/> Sinus tract (Y/N)<br><input type="checkbox"/> Swelling (Y/N)<br><input type="checkbox"/> History of Ortho tx (Y/N)<br><input type="checkbox"/> History of external resorption (Y/N)<br><input type="checkbox"/> Post (Y/N)<br><input type="checkbox"/> Caries | <input type="checkbox"/> Cold sensitivity (R/NL; R/L; NR)<br><input type="checkbox"/> Percussion sensitivity (S/NS)<br><input type="checkbox"/> Mobility (Miller's Class)<br><input type="checkbox"/> Bleeding on probing<br><input type="checkbox"/> History of bleaching (Y/N)<br><input type="checkbox"/> History of internal resorption (Y/N)<br><input type="checkbox"/> Retreatment (Y/N)<br><input type="checkbox"/> Surgical/nonsurgical treatment<br><input type="checkbox"/> Open margin (Y/N)<br><input type="checkbox"/> Resorption present (Y/N)<br><input type="checkbox"/> Duration of symptoms (mos.)<br><input type="checkbox"/> Fracture (Y/N): Type _____ |
|--|--|

PPD (mm)	Buccal	Lingual
<b>Mesial</b>		
<b>Direct</b>		
<b>Distal</b>		

Preoperative Radiographic findings:

Intact lamina dura (Y/N)                      Radiolucency (Y/N)    Size \_\_\_ x \_\_\_ mm

Preoperative Diagnosis:

- |  |  |
|--|--|
| <p style="text-align: center;">Pulpal:</p> <input type="checkbox"/> Normal pulp<br><input type="checkbox"/> Reversible pulpitis<br><input type="checkbox"/> Symptomatic irreversible pulpitis<br><input type="checkbox"/> Asymptomatic irreversible pulpitis<br><input type="checkbox"/> Pulp necrosis<br><input type="checkbox"/> Previously treated<br><input type="checkbox"/> Previously initiated therapy | <p style="text-align: center;">Apical:</p> <input type="checkbox"/> Normal apical tissues<br><input type="checkbox"/> Symptomatic apical periodontitis<br><input type="checkbox"/> Asymptomatic apical periodontitis<br><input type="checkbox"/> Acute apical abscess<br><input type="checkbox"/> Chronic apical abscess<br><input type="checkbox"/> Condensing osteitis<br><input type="checkbox"/> Lesion of non endodontic origin |
|--|--|

History of Trauma to tooth \_\_\_\_\_

Was CBCT Taken? \_\_\_\_\_

# APPENDIX E

## Registry/Cracked Tooth Intra-Operative Data Form

Subject #: \_\_\_\_\_

**PROTOCOL #410603 REGISTRY/CRACKED TOOTH INTRAOPERATIVE DATA COLLECTION FORM**

Working length established using electronic apex locator: Y/N

<b>Patency Achieved:</b>	
_____ Canal	Y/N
_____ Canal	Y/N
_____ Canal	Y/N
_____ Canal	Y/N
_____ Canal	Y/N
Was patency maintained throughout the procedure? _____	
How often? _____	

<b>Anesthetic used (Carpules):</b>	
2% Lidocaine w/1:100,000 epi	_____
0.5% Marcaine w/1:200,000 epi	_____
4% Articaine w/1:100,000 epi	_____
3% Mepivivaine	_____

<b>Procedure</b>	
Irrigant used, quantity (ml): _____	
Method of Irrigation:	
_____ Side-vented tip	_____ Passive ultrasonic
_____ Neg. Pressure	
Ca(OH) <sub>2</sub> used as interappointment medicament: Y/N	
Procedural complications:	Y/N Type: _____
Intraorifice barrier placed:	Y/N Type: _____
Number of treatment sessions:	single multiple

<b>Obturation:</b>	
_____ Flush (≤2 mm from apex)	
_____ Overextension (beyond apex)	
_____ Underextension (>2 mm short of apex)	
Type of obturation material	_____

<b>Retreatments</b>	
Type of obturation material removed:	_____
Method of removal:	_____

**Post treatment Diagnosis**

**Pupal**

- \_\_\_\_\_ Normal pulp
- \_\_\_\_\_ Reversible pulpitis
- \_\_\_\_\_ Asymptomatic irreversible pulpitis
- \_\_\_\_\_ Symptomatic irreversible pulpitis
- \_\_\_\_\_ Pulp necrosis
- \_\_\_\_\_ Previously treated
- \_\_\_\_\_ Previously initiated therapy

**Apical**

- \_\_\_\_\_ Normal apical tissues
- \_\_\_\_\_ Symptomatic apical periodontitis
- \_\_\_\_\_ Asymptomatic apical periodontitis
- \_\_\_\_\_ Acute apical abscess
- \_\_\_\_\_ Chronic apical abscess
- \_\_\_\_\_ Condensing osteitis
- \_\_\_\_\_ Lesion of non endodontic origin

Date of Treatment Completion: \_\_\_\_\_

**EVALUATOR USE ONLY**

Final treatment radiographic Periapical Index (PAI) score: 1 2 3 4 5

# APPENDIX F

## Registry/Cracked Tooth Follow-up Data Form

Subject #: \_\_\_\_\_

**PROTOCOL #410603-REGISTRY/CRACKED TOOTH FOLLOW-UP DATA COLLECTION FORM**

Date of follow-up evaluation: \_\_\_\_\_

Does patient have any of the following conditions (circle):

Hypertension: B/P \_\_\_\_\_ Smoker \_\_\_\_\_ Coronary Heart Disease \_\_\_\_\_ Diabetes Type: \_\_\_\_\_

Symptoms: Y/N

- |  |   |
|--|---|
| <input type="checkbox"/> Pain (0-10)<br><input type="checkbox"/> EPT/80<br><input type="checkbox"/> Palpation sensitivity (S/NS)<br><input type="checkbox"/> Sinus tract (Y/N)<br><input type="checkbox"/> Swelling (Y/N)<br><input type="checkbox"/> Time Elapsed Between Initial Tx and Permanent Restoration<br><input type="checkbox"/> Duration of symptoms | <input type="checkbox"/> Cold sensitivity (R/NL, R/L, NR)<br><input type="checkbox"/> Percussion sensitivity (S/NS)<br><input type="checkbox"/> Mobility (Miller's Classification)<br><input type="checkbox"/> Periodontal Screening Record (PSR)<br><input type="checkbox"/> Bleeding on probing |
|--|---|

PPD (mm)	Buccal	Lingual
Mesial		
Mid		
Distal		

Follow-up Radiographic findings:

Intact lamina dura Y/N \_\_\_\_\_ Radiolucency (Y/N) \_\_\_\_\_ Size \_\_\_\_\_ x \_\_\_\_\_ mm

Follow-up diagnosis: (Apical)

- |   |  |
|---|--|
| <input type="checkbox"/> Normal apical tissues<br><input type="checkbox"/> Symptomatic apical periodontitis<br><input type="checkbox"/> Asymptomatic apical periodontitis<br><input type="checkbox"/> Acute apical abscess<br><input type="checkbox"/> Chronic apical abscess<br><input type="checkbox"/> Condensing osteitis<br><input type="checkbox"/> Lesion of non endodontic origin | Caries present? Y/N _____<br>Permanent coronal restoration present? Y/N _____<br>Intracanal post present? Y/N _____<br>Open Margin Y/N? _____<br>Surgical or Nonsurgical Treatment _____ |
|---|--|

**EVALUATOR USE ONLY**

Final treatment radiographic Periapical Index (PAI) score:      1      2      3      4      5

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