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# UNIFORMED SERVICES UNIVERSITY OF THE HEALTH SCIENCES

POSTGRADUATE DENTAL COLLEGE  
NAVAL POSTGRADUATE DENTAL SCHOOL  
8955 WOOD ROAD  
BETHESDA, MARYLAND 20889



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Name of Candidate: Francine D. Seeto  
Master of Science Degree  
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THESIS/MANUSCRIPT APPROVED:

DATE:

Andrew J. Avillo  
COMPREHENSIVE DENTISTRY DEPARTMENT, NAVAL POSTGRADUATE DENTAL SCHOOL  
Committee Chairperson

Marina A. Hernandez-Feldpausch  
COMPREHENSIVE DENTISTRY DEPARTMENT, NAVAL POSTGRADUATE DENTAL SCHOOL  
Committee Member

Glen M. Imamura  
RESEARCH DEPARTMENT, NAVAL POSTGRADUATE DENTAL SCHOOL  
Committee Member

VARIATION IN DEGREE OF INTERVENTION FOR EXTERNAL CERVICAL  
RESORPTION

by

Francine D. Seeto,  
Maj, Dental Corps  
United States Air Force

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## **DEDICATION**

For my parents, Samuel and Bess Drummond

## **DISCLAIMER**

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## ABSTRACT

Variation in Degree of Intervention for External Cervical Resorption

Francine D. Seeto, DDS

Thesis directed by: Glen Imamura, Andrew Avillo, Marina Hernandez-Feldpausch

**Introduction:** External cervical root resorption (ECR) is an uncommon dental lesion with limited evidence-based treatment protocols or long-term outcomes reported in the literature. Its location on the cervical aspect of teeth and symptomatology create both diagnostic and prognostic challenges for the practitioners who first encounter ECR.

**Objective:** This online survey will evaluate: 1.) ECR treatment recommendations of general dentists and 2.) the influence of dental experience on their decision. **Method:** Participants will be provided the scenario of an active-duty member presenting for an annual dental examination in preparation for an extended deployment with limited dental assets available. They will then view up to 10 suspected ECR cases consisting of a 2-dimensional radiograph and clinical symptoms. At the conclusion of each case, they will select a treatment plan. Treatment planning recommendations among the full cohort of participants and the effect of years of clinical experience and advanced training on their treatment selection will be evaluated. **Results:** This survey has been reviewed and approved by the WRNMMC Institutional Review Board. It has been reviewed by the Navy Survey Office and Defense Health Agency and received approval from both

organizations for deployment to Navy Dentists. **Conclusion:** The survey results are pending.

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# CHAPTER 1: Review of Literature

## INTRODUCTION

External cervical root resorption (ECR) is an uncommon dental lesion. Its location on the cervical aspect of teeth and its symptomatology create a diagnostic challenge for dentists. The variety of treatment options contribute to the lack of a standardized treatment protocol. ECR presents with little to no associated pain and may be misdiagnosed as dental caries during radiographic and clinical examination if it can be identified (Stropko, 2012). Consequently, the diagnosis of ECR is predominately an incidental finding on either 2-dimensional (2D) or 3-dimensional radiography (3D).

ECR is thought to arise from inflammation initiated near the cemento-enamel junction (CEJ) via an external portal of entry apical to the periodontal attachment at the cementum (Mavridou, 2016). The inflammatory process involves osteoclastic resorption and replacement of tooth structure with a bone-like fibrovascular tissue.

Research on ECR continues to emerge but remains limited (Patel & Beddis, 2019). A current PubMed search identified 147 published papers of which 112 were case reports (Patel & Mavridou, 2018). Reviews by Heithersay (1997) and Patel, et al (2015) discuss the histopathology and possible predisposing factors for ECR. The pathophysiology of this resorption process involves both osteoblast and osteoclast activity. Osteoclasts play positive roles in oral histology as well in their homeostatic relationship with osteoblasts. They promote physiologic resorption of primary teeth, partner with osteoblasts to support

alveolar bone growth, and play a critical role in bone maintenance (prevention of osteoporosis and osteosclerosis). Osteoclasts also aid in repair mechanisms by creating future vascular space following dental trauma. The histopathology of ECR involves a defect in the cementoblast layer resulting in a disruption of the RANK-RANKL-OPG system (RANK=receptor activator of nuclear factor; RANKL=receptor activator of nuclear factor ligand; OPG=osteoprotegerin). Increased osteoclastic activity will follow up-regulation of RANKL and a down-regulation of OPG (Andreasen, 2008). Heithersay's 1999 etiologic study and Patel's 2017 systematic review identified predisposing factors associated with ECR. The factors with the highest percentages include a history of orthodontics, previous traumatic dental injury, occlusal parafunction, non-vital bleaching, poor oral health, or from an idiopathic source. Maxillary incisors, maxillary first molars, and mandibular first molars were associated with the highest percentages of ECR.

Patients with ECR typically remain asymptomatic. This has been attributed to the presence of a pericanalar resorption-resistant sheet surrounding the pulp (Patel & Mavridou, 2018). Lesion identification depends primarily on clinical examination or radiographic findings. However, ECR has no classic radiographic or clinical presentation. Clinical examination may reveal a cervical "pink spot" lesion resulting from newly vascularized tissue internally. When the resorption occurs subgingivally and is not visually accessible, it can mimic periodontal inflammation. Tactile probing may reveal a cavitated region that bleeds profusely when manipulated due to the disruption of newly laid down fibrovascular granulation tissue within the defect (Patel & Mavridou, 2018). Conventional dental radiographs commonly fail to capture the cervical region of interest, and if a cervical radiolucency is noted, it is frequently misdiagnosed as dental caries.

## MANAGEMENT

There exists a wide spectrum of treatment options for ECR. Treatment planning for invasive lesions located at the CEJ focus on removing the resorptive tissue to prevent recurrence. Heithersay (1999) first classified ECR into 4 categories based on apico-coronal involvement and treatment outcome success. A Class 1 lesion is defined as a small invasive cervical resorptive lesion. A Class 2 lesion is a well-defined lesion isolated to coronal tooth structure. A Class 3 lesion involves deeper apical involvement, and Class 4 lesion appears as extensive resorption extending beyond the coronal third of the root (Heithersay, 1999).

Mavridou et al. (2015) recently advocated for a newer three-dimensional classification incorporating measurements obtained using cone-beam computed tomography (CBCT). The European Society of Endodontology (ESE) released a position paper on ECR highlighting treatment options (Patel & Lambrechts, 2018). Modalities include periodic review, external repair of the resorptive defect with or without endodontic treatment, internal repair and root canal treatment, intentional replantation, and extraction. The ESE shared Mavridou's new three-dimensional classification for ECR and included height, circumferential spread, and proximity to the root canal measurements when evaluating potential treatment alternatives (Patel and Foschi, 2017).

Since an ECR diagnosis is challenging and there is limited long-term research on ECR treatment outcomes, clinicians are prone to misdiagnose or mismanage this lesion (Patel & Mavridou, 2018). Treatment modalities range from monitoring the lesion with no treatment to the most aggressive option, extraction of a non-restorable tooth. ECR is

an invasive lesion; it can progress at different rates and can present at accessible or inaccessible areas near the CEJ. Additionally, a patient's preferred treatment will also factor into the clinician's treatment plan decision. External cervical resorption (ECR) is typically an asymptomatic lesion noted as an incidental finding on conventional radiographs and CBCTs. In addition to multiple treatment options, military dentists must also take into consideration a patient's deployment readiness status when formulating treatment plans for ECR. Due to all the factors previously discussed, ECR remains an enigmatic lesion and presents diagnostic and treatment challenges for the dental practitioner.

Given the paucity of data on treatment preferences for ECR, the objectives of this descriptive survey are:

Objective 1: To describe treatment recommendations and their inter-provider agreement among the full cohort of providers.

Objective 2: To describe and compare provider treatment recommendations by years of provider clinical experience.

Additionally, dental readiness classifications assigned to the cases will be evaluated.

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

This descriptive survey will be limited to Navy general dentists with the following Naval Officer Designator codes; 1700, and/or 1725, and/or 1740. The investigators are seeking participation from 100 general dentists with clinical experience ranging from <1 year (not including dental school) to <30 years and the appropriate Naval Officer Designator code (see Figure 1).

**How many years have you been practicing as a dentist (not including dental school)**

\_\_\_\_\_years

**Please select your primary corresponding duty designators/ duty code:**

- 1700
- 1725
- 1740

**Figure 1. Demographic Data**

The survey will be voluntary, anonymous, and advertised in the ‘Clinical Update’ section of the Weekly Dental Update, a newsletter reaching all U.S. Navy dentists via e-mail. The advertisement will provide instructions on accessing the web-based survey. Participants meeting inclusion criteria will be directed to a Max.gov website that can be accessed using a home or work computer.

Once directed to the survey, participants will be provided instructions on using the survey tool and encouraged to view the images in a quiet, dim setting with a maximized screen (Figure 2.).

## **Instructions**

-We are trying to assess how Navy Dentists would provide treatment for an uncommon dental lesion. Use only the information provided on the slides. Do not access reference materials, textbooks, online websites, smart phones, etc. Please review all slides and radiographs in a dim, quiet room at a maximized size.

- You are conducting annual dental examinations (T-2) on 10 service members. All are deploying within the next 6 months, the deployment will be at least 6 months long, and there will be no access to routine dental care.

- For each of the 10 members, you will be provided a radiograph of a lesion with suspected external root resorption and the results of a clinical evaluation.

- Please answer each question. Once you finish answering a case, you will not be allowed to go back to review a previous case.

- Please return your completed survey by DD/MM/YEAR (date entered will be 4 weeks after appearing in the Weekly Dental Update)

- All responses will remain anonymous.

The selected bitewings with ECR lesions will be presented in random order (see Figure 3.). For each bitewing, the participant will select from a list of treatment plan options and assign a dental readiness classification.

**Figure 2. Survey Instructions**

The survey will be constructed using radiographic ECR lesions acquired via keyword search from submitted radiology reports cached in the WRNMMC IMPAX database. This database is limited to 3D cone beam computed tomography (CBCT) reports used to evaluate structures of the maxillofacial region. To locate patients with the highest likelihood for ECR, an IMPAX search will be conducted using the following terms: “*resorption*,” “*root resorption*,” “*cervical root resorption*,” “*external root resorption*,” “*invasive resorption*,” “*resorptive*,” “*inflammatory resorption*,” and “*resorbed*.” This study’s Principal Investigator (PI) and a board-certified Oral Maxillofacial Radiologist (OMR) will review the radiology reports and subsequently the CBCT images manually. All non-ECR cases of resorption will be excluded. Under no circumstances will study investigators contact patients, even if additional radiographic anomalies are discovered in their review of any the images reviewed or used for this study.

Definitive diagnosis of ECR is based on clinical findings and subject matter expertise interpretation (OMR review). A ‘gold standard’ diagnosis of ECR, based on clinical findings alone, has yet to be established. All CBCT images at WRNMMC require an OMR interpretation and subsequent report loaded to the IMPAX database. Using a keyword search in IMPAX will ensure that both CBCTs prescribed intentionally for resorption and ECR lesions identified incidentally will be populated from the keyword search. The identity (via Electronic Data Interchange Personnel Identifier number) of subjects with ECR lesions will be used to conduct a retrospective search in X-Ray Vision software to locate selected subject’s corresponding 2D images (bitewing, vertical bitewing, periapical, or panoramic radiographs) in the electronic dental database. All selected 2D images must have an identifiable radiolucent ECR lesion. Two-dimensional images were

selected for the study, as opposed to 3D images, because 2D images are more common and they are evaluated more often. These images are a standard of care required upon entering active service (bitewings, panoramic radiograph) and retaken with periodicity (1-2 years for bitewings at annual dental examinations and 5 years for panoramic radiograph). Two-dimensional radiographs are maintained on a digital dental radiograph database and readily available to clinicians during annual or emergent dental examinations.

Resorptive lesions on incisors and teeth requiring interproximal restorative treatment will be excluded to mitigate confounding diagnoses. Up to 10 cases of 2D images of ECR lesions will be selected for subject evaluation. Study team investigators and the OMR will also provide identical clinical symptoms for all cases. Providing identical clinical symptoms for all cases is possible because of the wide spectrum of potential symptoms to include seemingly counter-intuitive observations (i.e. it is possible for a patient with a Heithersay classification of 4 to experience no symptoms). All radiographs will be de-identified and no patient PII will be recorded. An example of how the case will appear on the Max.gov website is seen in Figure 3.

<b>Case 1</b>	(Two dimensional image) Any additional clinical symptoms
<b>Case 2</b>	(Two dimensional image) Any additional clinical symptoms
<b>Up to 10 cases</b>	(Two dimensional image) Any additional clinical symptoms

**Figure 3. Radiographic Case Presentation with clinical symptoms**

After viewing each case the participant will be asked to select from a list of 1 or up to 10 treatment options (Figure 4.).

Based on the radiograph and patient history, what treatment do you recommend for this tooth? Select **ALL** steps in your treatment sequence that apply.

- No treatment
- Remineralization therapy
- Return to clinic for radiographs in 12 months
- Return to clinic if tooth becomes symptomatic
- Return to clinic for radiographs in 6 months
- Direct restoration
- Indirect restoration
- Root canal therapy
- Orthodontic extrusion
- Extraction

**Figure 4. Treatment Plan Options**

The final question for each case will ask the participant to select a Dental Readiness Classification option for the simulated patient based on the lesion (Figure 5.).

According to your findings for tooth #\_\_, how would you classify the patient's dental readiness?

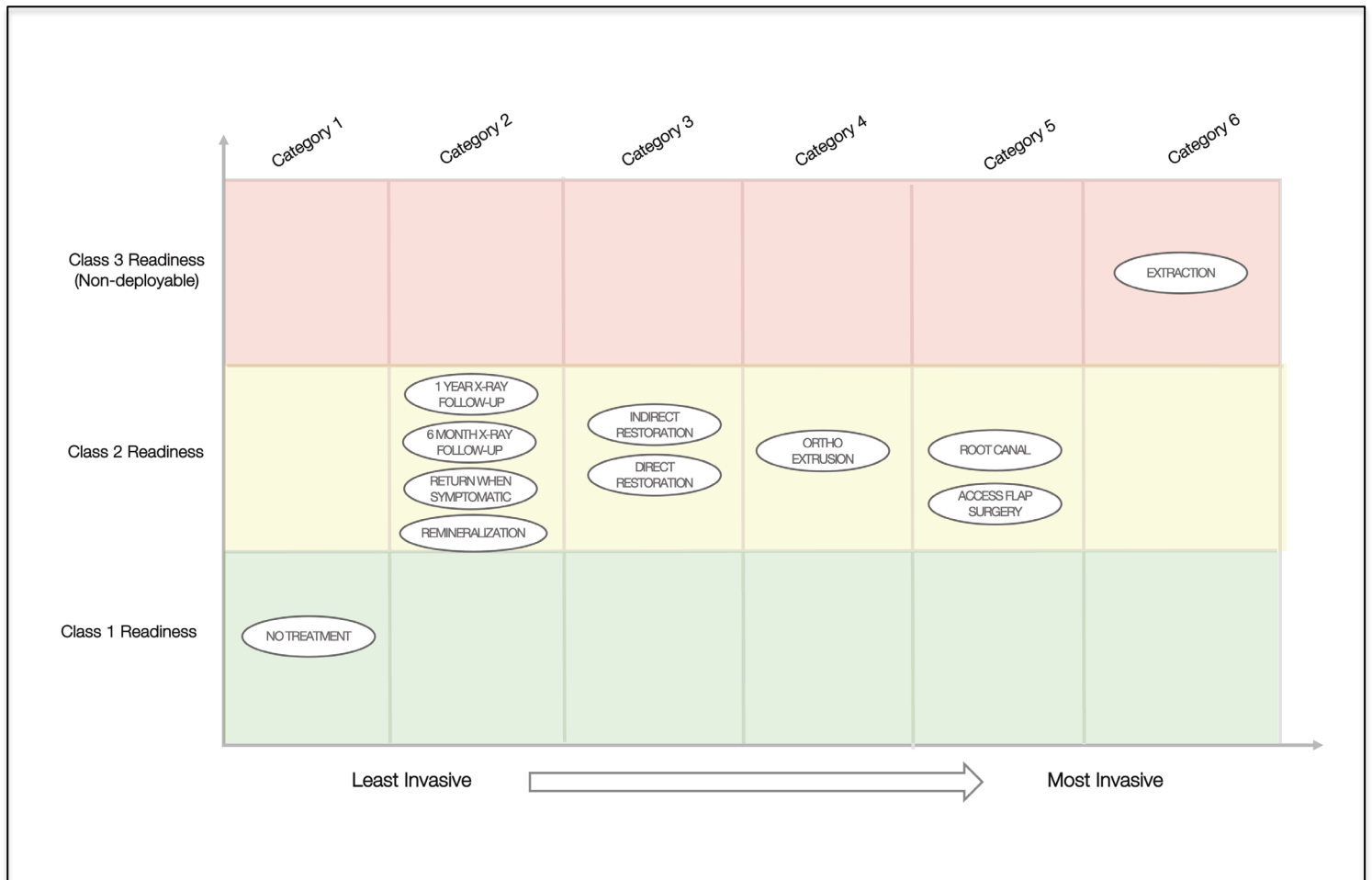
- Class 1 Readiness (Deployable; no dental needs anticipated within 12 months)
- Class 2 Readiness (Deployable; dental needs anticipated within 12 months)
- Class 3 Readiness (Non-deployable; dental needs anticipated within 12 months)
- Not applicable because I have never been a military dentist

**Figure 5. Readiness Classifications**

Upon completion of data analysis, it is planned to publish the study results in the 'Clinical Update' section of the Weekly Dental Update, thereby providing important clinical information on a lesion which dental practitioners do not commonly encounter and treatment plan.

### **CHAPTER 3: Anticipated Analysis**

Based on the expectation from our clinical experience that we will observe low agreement among our sample of raters, the primary analysis (Objective 1) will require 40 raters to complete review a minimum of 10 images to estimate an ICC of 0.2 with a confidence interval width of  $\sim 0.3$  ( $\sim \pm 0.15$ ), or to estimate an ICC of 0.1 with a confidence interval width of  $\sim 0.2$  ( $\sim \pm 0.1$ ). Up to 10 images will be selected using a range of case severities that are anticipated to solicit variation in treatment ratings across the range of the 1-6 scale (Figure 6). An anticipated available sample size 100 surveys will allow additional analyses to describe and compare absolute treatment rating and level of agreement by years of provider clinical experience. Assuming only 30% of surveys will be returned completed and approximately 700 Navy Dentists have a Naval Officer Designator code of 1700, and/or 1725, and/or 1740, it is anticipated that 200 will return completed surveys.



**Table 1. Levels of Treatment Intervention Rubric (Ordinal Data)**

Descriptive statistics (e.g., mean and standard deviation or median and range) will be reported for the provider's average treatment recommendation score (1-6 scale) for all ~10 rated images, among the full cohort and stratified by years of clinical experience. To describe agreement in treatment recommendations between providers (Objective 1), inter-rater agreement will be estimated using a two-way random intra-class correlation coefficient (ICC) for single measure, absolute agreement, as supported by the R irr package (Gamer et al. 2019). Agreement will be reported as the model-estimated ICC and its 95% CI among the full cohort. Additional analyses will estimate the ICC among provider strata defined by years of clinical practice, excluding dental school, and categorized as follows; 0-3 years, >3-6 years, >6-12 years and >12 years (Clarke B, et al. 2020). Graphical displays (e.g., dot plots) will be used to illustrate variability in treatment recommendations within and between images. Secondary analyses will use anova or non-parametric alternative (as appropriate to the distribution of the variable) to compare the reported provider average treatment recommendation scores by years of clinical experience strata. A mixed effects model will be used to estimate the association of clinical experience with treatment recommendation scores. The model will include a fixed effect for clinical experience category and random effects for image and rater. Additional, exploratory analyses will describe and compare dental readiness ratings and level of agreement (e.g., using Fleiss' Kappa) among the full cohort and stratified by years of experience.

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