

# Evaluating Near Infrared Imaging (NIRI) in Intraoral Scanners for Interproximal Caries Detection

---

*2022 Research Aid Awards (RAA)*

*Dr Adam Hoxie*

---

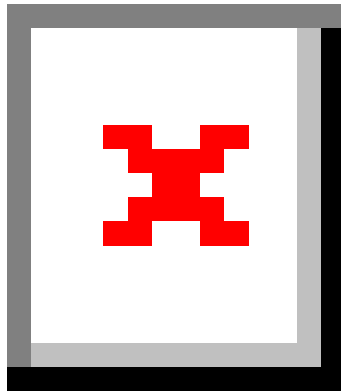
adhox@live.unc.edu  
O: 952-686-3431

# FollowUp Form

---

## *Award Information*

---



*In an attempt to make things a little easier for the reviewer who will read this report, please consider these two questions before this is sent for review:*

- Is this an example of your very best work, in that it provides sufficient explanation and justification, and is something otherwise worthy of publication? (We do publish the Final Report on our website, so this does need to be complete and polished.)*
- Does this Final Report provide the level of detail, etc. that you would expect, if you were the reviewer?*

### **Title of Project:\***

Evaluating Near Infrared Imaging (NIRI) in Intraoral Scanners for Interproximal Caries Detection

### **Award Type**

Research Aid Award (RAA)

## Period of AAOF Support

July 1, 2022 through June 30, 2023

## Institution

Graduate Orthodontic Residency Program, Division of Craniofacial and Surgical Care, UNC Adams School of Dentistry

## Names of principal advisor(s) / mentor(s), co-investigator(s) and consultant(s)

Apoena de Aguiar Ribeiro, DDS, MS, PhD, a. Associate Professor, Division of Diagnostic Sciences. Kelly B. Mitchell, DDS, MS, a. Director of Clinical Education, Graduate Orthodontic Residency Program. a) UNC Adams School of Dentistry.

## Amount of Funding

\$5,000.00

## Abstract

(add specific directions for each type here)

This project aims to assess whether the near infrared imaging (NIRI) technology found in modern intraoral scanners is a reliable means of detection for interproximal initial, non-cavitated carious lesions. A set of ex vivo extracted human teeth (n=60) will be selected for smooth surface carious lesions (n=40) and for sound controls (n=20), and will be scanned via micro-CT as a gold standard. The surfaces of interest will be mounted in dentiform to allow for NIRI scanning using an intraoral scanner, followed by NIRI image interproximal caries diagnosis by two calibrated examiners. The specific aims of this study are to assess the reliability, sensitivity, and specificity of NIRI interproximal caries detection on an intraoral scanner against micro-CT, a validated, non-invasive gold standard, as well as bitewing radiographs to serve as the clinical standard. The findings of this study will contribute to our understanding of the value of NIRI technology found in intraoral scanners. More specifically, should orthodontists accept and use the NIRI intraoral scanner's identification of interproximal caries to guide clinical decisions?

## *Respond to the following questions:*

---

### Detailed results and inferences:\*

If the work has been published, please attach a pdf of manuscript below by clicking "Upload a file".

OR

Use the text box below to describe in detail the results of your study. The intent is to share the knowledge you have generated with the AAOF and orthodontic community specifically and other who may benefit from your study. Table, Figures, Statistical Analysis, and interpretation of results should also be attached by clicking "Upload a file".

AAOF Results Final Report.pdf

The specific aim of our study was to compare NIRI interproximal caries detection in the intraoral scanner to a micro-CT gold standard. This study achieved that goal by selecting a group of 85 interproximal surfaces on extracted posterior teeth selected for sound control, interproximal enamel lesions, and interproximal dentin lesions using micro-CT gold standard. Our two trained and calibrated examiners reviewed images of the NIRI scans along with clinical photos, mimicking the clinical scenario of capturing a chairside intraoral scan in an orthodontic office. Without any additional aids, the examiners demonstrated high specificity (0.83-0.96 (95% CI: 0.69-0.99)) and moderate sensitivity (0.42-0.63 (95% CI: 0.26-0.78)) when evaluating for caries using the NIRI intraoral scan.

Given the high specificity and relatively lower sensitivity, NIRI as a standalone tool may be best viewed as a screening aid. An orthodontist that identifies a NIRI-positive interproximal surface should feel confident following up on that surface with a bitewing radiograph for a definitive diagnosis.

With one year left in my program, my future direction for the project is to evaluate whether the specificity and sensitivity change when NIRI is used in combination with bitewing radiographs, a situation that may mimic the next natural step in the caries diagnosis decision.

### **Were the original, specific aims of the proposal realized?\***

We addressed the original aims of the proposal, which included comparing NIRI interproximal caries detection using the intraoral scanner to a micro-CT gold standard. Our next steps are to compare NIRI to the current clinical standard, bitewing radiographs.

### **Were the results published?\***

No

### **Have the results of this proposal been presented?\***

Yes

### **To what extent have you used, or how do you intend to use, AAOF funding to further your career?\***

The AAOF Research Aid Award has encouraged me to pursue my interest in orthodontic research. The funds allowed me to design and execute a more ambitious research project during my residency than I would have otherwise. Using the AAOF funds, I had the ability to carry out a substantial project that I was proud to present at the AAO Table Clinic at the 2023 AAO Annual Session in Chicago, IL. Participating in AAO as a resident was an incredible experience, as I enjoyed learning in the variety of formats that content is disseminated. However, contributing to the knowledge base and content presented at the AAO Annual Session was an exciting opportunity that I won't forget. It was rewarding to present amongst my colleagues at the AAO Table Clinic, and the discussions during my presentation encouraged new future directions for my project. These funds also allowed me to generate enough data to begin mentoring students as they helped execute and present this project. The opportunity to mentor dental and undergraduate students helped me grow as a teacher and orthodontist. Overall, the AAOF funding has continued to reinforce my passion for research in orthodontics, and I hope to continue contributing to orthodontic research throughout my career.

## Accounting: Were there any leftover funds?

\$0.00

## *Not Published*

---

### Are there plans to publish? If not, why not?\*

We plan to publish this study following final data collection. Our remaining goals are to collect bitewing radiograph examinations to compare the current clinical standard to NIRI. Our evaluators will also assess both bitewing radiographs and NIRI images in combination to evaluate whether these technologies are more effective at interproximal caries diagnosis in tandem rather than as standalone technologies.

## *Presented*

---

### Please list titles, author or co-authors of these presentation/s, year and locations:\*

Hoxie, A; Patel, P; Perumbedu, A; Mitchell, K; Broome, A; Vasconcellos, AB; Ribeiro, AA. "Evaluating near infrared imaging (NIRI) in intraoral scanners against Micro-CT gold standard: an ex vivo study." Table Clinic, AAO Annual Conference, May 2023, Chicago, IL

### Was AAOF support acknowledged?

If so, please describe:

Yes, a written statement thanking the AAOF for their support of the project was included on the poster.

## *Internal Review*

---

### Reviewer comments

### Reviewer Status\*

## File Attachment Summary

---

### *Applicant File Uploads*

- AAOF Results Final Report.pdf

## Results

Micro-CT analysis was used to identify extracted posterior human teeth with two-evaluator gold standard confirmation of sound surfaces (n=47), non-cavitated interproximal lesions limited to enamel (n=30), and extending into dentin (n=8). When evaluating examiner reliability, there was a statistically significant difference (p= 0.001) between the two NIRI evaluators detecting lesion presence (Table 1). Sensitivity ranged from 0.42-0.63 (95% CI: 0.26-0.78) and specificity ranged from 0.83-0.96 (95% CI: 0.69-0.99) for detecting lesion presence relative to the gold standard. The inter-examiner kappa score showed good strength of agreement (k=0.68) between examiners detecting lesion presence and the weighted kappa for inter-rater reliability for lesion severity evaluation showed moderate agreement (k=0.71). Full agreement statistics with the gold standard micro-CT exam are shown in Table 3.

**Table 1.** Sensitivity and specificity values for the NIRI examination compared to micro-CT gold standard. 95% confidence intervals are shown in parentheses.

	Evaluator 1	Evaluator 2
Sensitivity	0.42 (0.26-0.59)	0.63 (0.46-0.78)
Specificity	0.95 (0.85-0.99)	0.83 (0.69-0.92)

**Table 2.** NIRI reliability statistics from the calibration to detect lesion presence (unweighted kappa) and lesion severity (weighted kappa)

	Inter-examiner	Intra-examiner
Unweighted kappa	0.68	1.00
<b><u>Weighted kappa</u></b>	<b><u>0.71</u></b>	0.90-1.00

**Table 3.** Agreement statistics comparing NIRI evaluator scores against micro-CT gold standard

<b><u>Sensitivity</u></b>	<b><u>0.42-0.63</u></b>
<b><u>Specificity</u></b>	<b><u>0.83-0.96</u></b>
Positive predictive value	75.0-88.9%
Negative predictive value	73.2-67.1%
Accuracy	74.1-71.8%
Weighted kappa	0.45-0.46

---