

Innovations in Aiding Caries Detection: *How iTero Near-Infrared Imaging Technology Can Impact Your Practice*

Caries detection can often vary depending on the tooth surface in question. For occlusal pit and fissure lesions, visual and tactile detection can normally suffice. Bitewing radiographs have long been the most practiced method for detection of interproximal lesions, yet there are limitations, such as the inherent use of ionizing radiation for imaging, overlapping contacts, and unclear exposure contrast. Due to such considerations, alternative options for early caries detection have been sought after to supplement traditional radiographs. Some methods that have caught traction are based on the optical properties of tooth structure and include methods based on laser fluorescence as well as transillumination with near-

infrared light. The focus of this paper will be on how near-infrared light has proven to be an effective method for aid in detecting interproximal caries.

Caries detection using near-infrared light is based on the different ways that varying tooth structure interacts with said light. For instance, intact enamel is found to be relatively transparent when transilluminated with it. This, however, is not the case when a carious lesion is present. Lesions in the enamel cause scattering of this light, and it is this fact that allows for distinguishing between sound and carious enamel with this technology.

When utilizing an intraoral scanner with integrated near-infrared light reflection technology, teeth are exposed to near-

About the Author



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Dr. Steven Glassman has treated more than 2,000 Invisalign patients since 2002 and has been a member of the Align Faculty since 2004. A pioneer in digital scanning, Dr. Glassman was one of the first users of the iTero digital scanner in the world and continues to publish and lecture on comprehensive digital workflows. In 2005, he was recognized by his peers as the winner of the Invisalign Case Shoot Out, where his case was chosen from among thousands of entries. He is a proud graduate of Brandeis University and the Columbia University School of Dental Medicine. He practices with his wife in the Lincoln Center area of New York City and focuses on cosmetic, implant, and aligner therapy. In 2018, he was named to the Zimmer Biomet faculty, adding to the digital workflow of aligners and implants. In 2020, he received the award for 15 years of service. Recently, he was the first to use the iTero Element 5D imaging system in the United States



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infrared light and their reflection is given as a gray scale image. Here, sound enamel appears dark, while the carious lesion, which scatters and reflects the near-infrared light, appears brighter in comparison. Dentin is also reflective and will appear brighter than enamel. An example of a system that utilizes this technology is the iTero Element 5D scanner, an integrated intraoral dental imaging system that simultaneously captures 3D color images of the dentition and produces near-infrared light images (NIRI) that can be utilized to aid in interproximal caries detection. The translucency of the scanned tooth structure when exposed to near-infrared light translates to the brightness level in the resulting captured image. The iTero Element 5D imaging system can capture NIRI images from multiple angles and automatically store them during the scan.

The effectiveness of NIRI technology has support from the findings of several studies. One such study was a multicenter, prospective study conducted in five separate general practice clinics in Canada and Germany, with the aim to compare detection of early interproximal caries using reflected near-infrared imaging and bitewing radiographs under real-life conditions.¹ A total of 100 patients, all of whom attended these clinics between April and November of 2020, consented and were included in the study (n=20 per clinic). All of the included patients were scheduled for bilateral bite wing radiographs as part of their regular care, as well as a full scan of both maxillary and mandibular arches using the iTero Element 5D imaging system. This scan produced an NIRI image in gray scale along with the 3D color image of a given tooth or pair of teeth. Both the bitewing radiograph and the NIRI image were used to detect interproximal caries. In addition, the study compared NIRI and bitewing radiography to visual caries debridement.

The results demonstrated high accuracy ($p < 0.0001$)

detection of early enamel lesions (88.6%) and of carious lesions involving the dentino-enamel junction (96.9%).¹ When compared against clinical evaluation of posterior proximal lesions observed during caries debridement, the NIRI technology of the iTero Element 5D imaging system was 66% more sensitive than bitewing X-ray and demonstrated 96% sensitivity for posterior interproximal lesions detections.

The results of this study support the efficacy of the iTero Element 5D's NIRI interproximal caries detection aid feature when compared to traditional bitewings. In fact, this study found that while NIRI had comparable sensitivity to bitewings in the detection of interproximal caries reaching the dentino-enamel junction, it had higher sensitivity in the detection of early interproximal enamel lesions.¹ This illustrates an important potential benefit for utilizing this technology as a diagnostic aid tool and gives good reason to consider adding this technology to any modern practice.

A second study recently completed in Germany has also found favorable results regarding the iTero Element 5D imaging system's caries detection capabilities.² Here, 250 extracted permanent molars and premolars, selected from a pool of anonymous patients, were vertically mounted, paired off, and approximated to mimic a natural proximal contact. Both bitewing radiographs and scans were completed on the teeth and caries detection capabilities were compared. These teeth were also assessed with a μ CT 40 micro-computed tomography scanner, which was used as a reference for caries detection. The results of this study showed that the iTero Element 5D imaging system's detection capabilities were comparable to those of bitewing radiographs. In fact, the NIRI with and without the trilateral (buccal/lingual/occlusal) information was able to detect initial caries defects in enamel with higher sensitivity than bitewings.



This study also highlighted an innovative and effective diagnostic aid function of the iTero Element 5D imaging system. Another added benefit is that, since the images are recorded from various angles, surfaces of teeth are recorded from all sides, providing more information than other intraoral scanners that save individual images.² This data is all displayed on the monitor for both the practitioner and patient to see. Combined, these features not only assist practitioners in the diagnosis of caries, but can also aid in patient education and allow the patient to gain a better understanding of their current state of oral health.

Originally created to replace traditional impression materials for the purposes of records and fabrication of dental appliances, contemporary intraoral scanners provide practitioners with much more. For instance, modern advancements like oral health assessment tools and integrated intraoral cameras can aid practitioners in diagnosis and treatment planning, while visualization tools serve to improve communication and patient education. With the iTero Element 5D imaging system, these benefits are all acquired with just one scan, leading to improved workflow. And with its integrated NIRI technology, this system can help practitioners detect supragingival interproximal caries that could have otherwise gone undetected, preventing potentially irreversible damage before it has the chance to occur. Such technological advancements are helping revolutionize the field of dentistry and are increasingly making an impact in dental clinics around the world. From personal experience, the

versatility of the iTero Element 5D imaging system has helped my office run more efficiently and streamlined procedures. Its ease of use and all-in-one functionality have allowed for improved workflow, all while helping me educate patients on its impressive display monitor. Overall, this product has improved clinical life for both me and my staff, while helping to create better clinical outcomes for my patients.

References

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