

Assessment of Early Occlusal Caries Pre- and Post- Sealant Application—An Imaging Approach

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Background and Objective: Clinicians have difficulty assessing and monitoring early occlusal caries. Traditional clinical exam and radiographs are unable to detect the subtle alterations in enamel indicative of de- or remineralization, particularly under dental sealants. Although clinicians have used laser fluorescence (LF) to address this gap, this modality has demonstrated weak correlation with histology. The International Caries Detection and Assessment System (ICDAS-II) has demonstrated high sensitivity and specificity for caries detection, but since it is based on visual assessment, it is of no use in areas beneath the most commonly used dental sealants which are opaque. Optical coherence tomography (OCT) is an emergent assessment tool which has demonstrated great promise in detecting and quantifying caries, including areas beneath commonly used dental sealants and composites. However, OCT has not yet been widely integrated into clinical dental practice, perhaps because OCT imaging does not provide an easily accessible diagnostic outcome for clinicians. The objective of this *ex vivo* study was to use OCT-images of sound and carious occlusal surfaces in combination with a simple algorithm to compare the caries detection ability of OCT with tools clinicians may be more familiar with (LF and radiography), and with an established valid and reliable clinical assessment tool (ICDAS-II).

Study Design/Materials and Methods: One hundred twenty extracted teeth with sound or naturally carious occlusal surfaces were imaged with OCT, LF, radiography, and examined clinically with the ICDAS-II. Teeth were randomized to one of two dental sealants recommended for use with LF. A novel simple algorithm was used to interpret OCT-based images. The accuracy of caries severity assessments of the OCT-based diagnosis, LF, ICDAS-II, and digital radiography were compared to the 4-point histological analysis gold standard.

Results: OCT and ICDAS-II caries severity assessments demonstrated high sensitivity (94.0%; 92.3%) and specificity (85.0%; 83.3%), LF demonstrated low sensitivity (65.2%) but high specificity (97.6%), and digital radiography demonstrated low sensitivity (67.1%) with moderate specificity (79.5%) on unsealed occlusal surfaces. OCT-

based caries severity assessments of sealed teeth demonstrated high specificity (97.6%), sensitivity (89.9%), excellent positive predictive value (98.6%), and negative predictive value (83.3%). Despite our use of LF recommended dental sealants, in the presence of sealants, LF assessment of caries severity demonstrated high sensitivity (95.1%), but extremely low specificity (10.3%), positive predictive value (68.8%), and negative predictive value (50.0%).

Conclusion: This study found that OCT-based imaging combined with a simple diagnostic algorithm accurately assessed the severity of natural early caries on occlusal surfaces in extracted teeth both in the absence and presence of dental sealant. The findings of this study support the clinical use of OCT imaging for assessment and monitoring progression of early non-cavitated caries lesions on occlusal surfaces including areas under dental sealants. *Lasers Surg. Med.* 46:499–507, 2014.

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INTRODUCTION

Clinicians and researchers need to be able to detect minimal changes in enamel health to accurately assess caries progression and manage early occlusal caries [1].

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Traditional radiographs and clinical exam are unable to detect minimal changes in enamel indicative of early caries progression and de- or re-mineralization. Clinically accessible quantifiable assessment would provide clinicians with vital information about the efficacy and cost-effectiveness of non-invasive and minimally invasive caries prevention and management strategies such as dental sealants, enhancing very early caries management. The current lack of such capabilities may contribute to the underuse of dental sealants despite solid evidence of the efficacy of sealants for limiting progression of non-cavitated caries lesions [2–4].

Emergent caries assessment tools, such as the International Caries Detection and Assessment System (ICDAS-II), laser fluorescence (LF), and Optical Coherence Tomography (OCT) can augment the ability of clinicians to assess and predict caries progression [5–10]. ICDAS-II uses visual assessment of the tooth's natural enamel surface, taking advantage of the change in the enamel refractive index resulting from repeated demineralization challenges to detect and assess caries, including non-cavitated lesions, and provides clinically meaningful measurements [11]. ICDAS-II demonstrates excellent caries detection ability on natural occlusal surfaces [12,13]. However, ICDAS-II techniques do not detect or quantify the minute changes associated with early enamel de- or re-mineralization [14], and because the methodology is based on visual assessment, it is of no use in assessing pits and fissures underneath the most commonly used dental sealants as they are opaque. DIAGNOdent (KaVo, Biberach, Germany) is a widely used non-invasive, non-ionizing LF-based system that provides a numerical value of autofluorescence in a digital display as an indicator of caries status. This device detects the fluorescence resulting from exposure to red light (655 nm wavelength) of porphyrins from cariogenic bacteria. LF has been used to quantify demineralization of tooth structure, including areas covered by unfilled clear dental sealants [15,16]. However, LF scores have demonstrated a weak correlation with histology [14], generating a high rate of false positives [17]. Optical coherence tomography (OCT) creates an image of tissue based on reflectivity and phase retardation related to the mineral and water content of the surface and subsurface of the tissue being imaged [18]. OCT has been used extensively in clinical medicine [19–23] but less so in dentistry [24]. This lack of use may be surprising since researchers have found that OCT can be used to assess caries severity including very early caries on occlusal surfaces [12,13,25–29], to diagnose and even quantify changes in enamel structure associated with remineralization [9,10,25,30–33], with the ability to diagnose effectively even under a variety of dental sealants and composites [6,34–36]. This lack of clinical OCT use may reflect clinicians' challenges in interpreting the OCT images [37] and the absence of a simple diagnostic readout for clinicians [13].

The objective of this *ex vivo* study was to compare current clinically used assessment tools - LF, ICDAS-II, and intraoral digital radiographs—with OCT-based diagnosis

using a novel simple algorithm in extracted sound and carious teeth before and after sealant placement. Histological examination using the validated methodology proposed by Ekstrand et al. [38] was used as the gold standard.

MATERIALS AND METHODS

Protocol

One hundred twenty extracted human molars were collected by researchers at the University of Michigan. The use of extracted teeth for this study was approved by the University of Michigan IRB. The teeth were cleaned, and sterilized with ethylene oxide gas. After marking the area of interest on each tooth with a small 330 bur and indelible ink, teeth were categorized by consensus from two trained and calibrated examiners (J.B. and M.F.) according to ICDAS II criteria (0–4). The 120 randomly numbered samples included, 40 sound teeth and 20 teeth in each of the ICDAS II lesion categories (1–4). Samples were photographed and then radiographed using a wireless Schick digital sensor (3 mA, 70 kVp, 0.050 seconds). The occlusal surface of teeth in each radiograph were evaluated at a later date by trained examiners (J.B., E.B.) using the following scale: (1) Lesion presence: yes/no; and (2) Lesion depth: E = lesion in enamel; D1 = outer third of dentin; D2 = middle third of dentin; D3 = Inner/pulpal third of dentin [38,39].

Samples were then imaged with LF (DIAGNOdent). The DIAGNOdent LF system uses two-way handpiece optical system connected to a table top base unit to measure the fluorescence within tooth structure. The handpiece is placed on the tooth, and pulses of specific wavelength of red light illuminates the surface of the tooth causing porphyrins in cariogenic bacteria to fluoresce. The light emitted from the tooth's surface is transmitted through the handpiece to the base unit where it is analyzed, quantified, and a numerical value displayed. The LF unit was calibrated according to the manufacturer's instructions prior to each use. A "Zero Baseline Reading" was determined for each tooth. For each specimen, the marked area of interest in the occlusal surface of the tooth was scanned with the probe by slowly rocking the wand in a pendulous motion capturing the highest reading or "the peak." Measurements were repeated until 3 readings were within (\pm) 3 units of each other, and then recorded for that surface. Teeth were subsequently wrapped in gauze moistened with 0.1% thymol and sent to researchers at Beckman Laser Institute (BLI) at the University of California Irvine for OCT imaging.

At BLI, teeth were unwrapped, wicked to nearly dry with a wedge of fine filter paper, placed on a wax base with the occlusal surface horizontal, and then the area of interest was imaged with a prototype swept-source-optical coherence tomography system (SS-OCT). After initial OCT imaging, teeth within each ICDAS-II category were randomly assigned to one of two dental sealants recommended for use with LF: ClearVue (Denali Corp. denalincorporation.com, Hannover, MA)—(Group 1) or Helioseal Clear (Ivoclar Vivadent, Amherst, NY)—(Group 2). These

sealants were chosen in order to maximize the ability of LF to accurately categorize the soundness of the occlusal areas covered by dental sealant. Materials were applied according to manufacturers' instructions and cured with Elipar Freelight 2. Following sealant placement, teeth were reimaged with SS-OCT, wrapped in gauze moistened with 0.1% thymol, and returned to the University of Michigan for post-sealant LF scanning and histological analysis. Re-examination with ICDAS-II and radiographic assessments post-application were not conducted. For histological analysis, individual teeth were hemisected through the marked area of interest using micro-slice machine with a 250 μm thick annular blade. The plane of the section was bucco-lingual but modified by the appearance of the fissure system. Both sections of the hemisected teeth were viewed independently by two trained examiners (J.B., C.G.C.) without magnification and under a stereomicroscope (5 \times) measuring the extent of the lesion using the 4-point criteria as proposed by Ekstrand [38]. The 4-point criteria scores the depth of enamel and dentin demineralization scoring no enamel demineralization (0), enamel demineralization limited to the outer 50% of the enamel (1), demineralization involving between 50% of the enamel and 1/3 of the dentin (2), demineralization involving the middle 1/3 of the dentin (3), and demineralization involving the inner 1/3 of the dentin (4).

OCT Imaging

Optical coherence tomography (OCT) is a non-invasive imaging modality that uses near-infrared light to obtain high-resolution surface and subsurface images. Several OCT systems have FDA approval for clinical use in dentistry. In vivo the image is acquired by a flexible fiber optic that is placed on the surface of the tooth to generate a real-time image of the immediate surface and subsurface tissues.

Previous studies have shown that swept-source OCT (SS-OCT) of dental tissues is able to differentiate between the reflectance signals of resin, enamel and dentin, including demineralized tooth structure [6,7,40–43]. Figure 1 shows the SS-OCT system used in this study. Light from a swept-source laser (sweeping speed = 20 kHz, 1,310 nm centered wavelength, with a FWHM bandwidth of 75 nm) is directed into a 1 \times 2 10:90 coupler, with 90% power in the sample arm and 10% power in the reference arm. The back-reflection signal from the reference arm and the backscattered signal from the sample arm are guided into a 2 \times 2 50:50 split ratio coupler. The two signals interfere with each other to create fringe signals that are sent into a balanced amplified photodetector. The amplified signal from the detector is then digitized and processed by the computer to create cross-sectional images. The scanning system consists of two scanning mirrors and a focusing lens. The mirrors are synchronously controlled by the computer to direct the light beam to scan over a horizontal axis of 6 mm using a 2D imaging acquiring setup or to acquire scans over an area of 6 mm by 6 mm with 3D setup. In the case of 3D setup, the images acquired can be

stacked together to create a 3D representation of the sample. The axial resolution of the images obtained from this system is approximately 8 μm while the lateral resolution is around 10 μm . The system acquires images at a rate of 33.3 frames per second.

Prior to each image acquisition, the light beam was focused by a trained and experienced operator (A.W.) to project the narrowest line possible onto the tooth surface during each imaging scan. Samples were adjusted so that the scan line remained as perpendicular as possible to the tooth surface throughout the entire 6 mm length of each scan. Sample orientation, scan localization, and OCT system probe and parameters were standardized throughout the entire study to ensure comparability and reproducibility of the data obtained. Thus extensive measures were undertaken to minimize the effects of variables such as beam focusing on the data obtained, especially on the signal intensity to optical distance ratio.

In order to maximize the comparability of the images obtained and take into account tooth surface curvature, the reflection peak at the air/enamel surface in each OCT image was aligned along one horizontal pixel line in each image. After filtering for noise with an adaptive Frost filter [44,45] each two-dimensional image (B-scan) was analyzed with simple software written by our lab (A.C., P.W.S.). The surface 15 pixel layers of the tooth were excluded from this analysis because of the permanent reflection peak at the air/tooth interface.

Diagnostic Criteria

Teeth that scored 0 on the ICDAS-II scale (no evidence of caries or change in translucency and light refraction of enamel after drying for 5 seconds) were considered sound (E0) and an ICDAS-II score of 1 (opacity or discoloration, white or brown, visible at the entrance to the pit, or fissure after prolonged air drying) was considered early caries (E1). LF scores of 0–7 were considered sound (E0) and 8–14 demineralized/early caries (E1) [46]. To determine diagnoses with OCT-based images, the two-dimensional OCT images (B-scan) were analyzed with a software program. Locations with a log of back-scattered light intensity (BSLI) below 2.9 were scored as sound (E0), and areas equaling or exceeding 2.9 were considered to be carious (Table 1). This cut-off point was chosen based on our preliminary data in a previous pilot study. Images were also examined visually to map the physical extent of the demineralization due to caries (E1-D2). Teeth were considered radiographically sound if there was no discernible lesion present. After hemisectioning, histological analysis (gold standard) using the 4-point criteria as proposed by Ekstrand et al. [38] was conducted. Teeth were categorized as sound (E0), demineralized/early caries (E1), or more severely decayed (E2, D1, D2).

RESULTS

OCT, LF, ICDAS-II, and radiograph assessments pre- and post-sealant were compared with the gold standard (histopathology) (Tables 1–3). Table 1 shows the

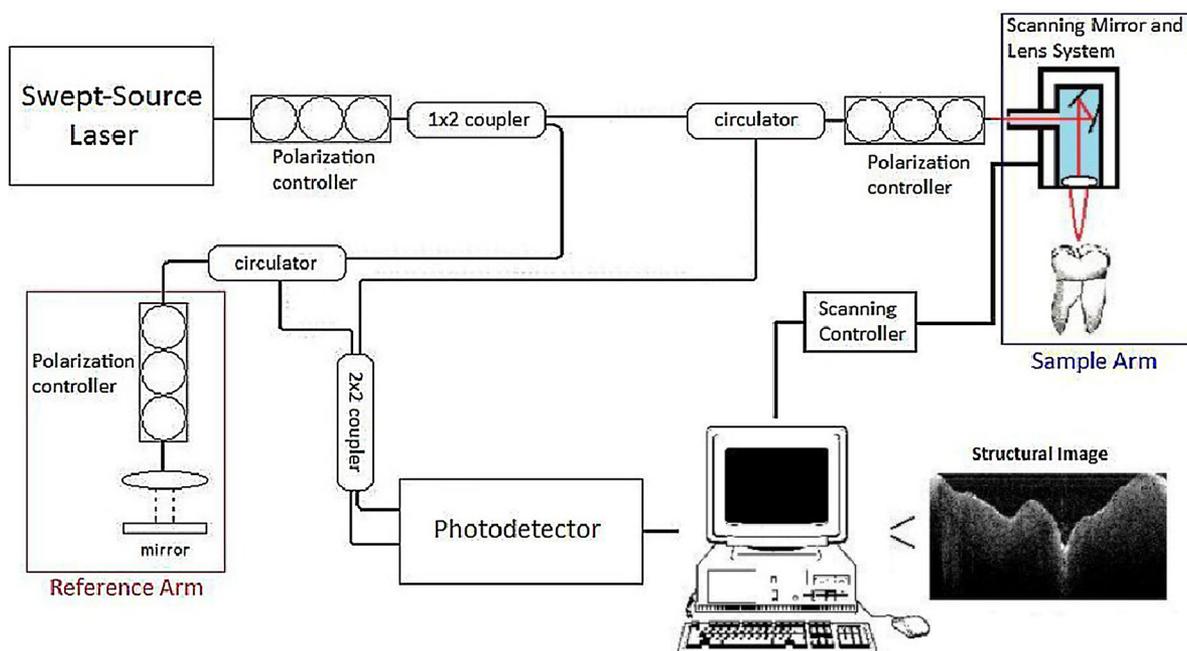


Fig. 1. OCT System setup.

comparison of all four assessment methods pre-sealant application, and the OCT-based and LF assessments post-sealant application. The OCT-based imaging combined with a simple diagnostics algorithm accurately assessed

the severity of natural early caries on occlusal surfaces both in the absence and presence of dental sealant. Diagnostic characteristics for both dental sealants were similar (Table 1). The presence of either dental sealant on

TABLE 1. OCT, LF, ICDAS-II, and Radiograph Assessment of All Teeth Versus Histopathology (Gold Standard)

	Before sealant applied				After sealant applied	
	OCT ^a (%)	LF (%)	ICDAS (%)	Radiograph (%)	OCT (%)	LF (%)
All teeth (<i>n</i> = 120)						
PPV ^b	91.3	93.2	91.1	86.9	98.6	68.8
NPV	89.5	65.6	85.4	54.4	83.3	50.0
Sensitivity	94.0	65.2	92.3	67.1	89.9	95.1
Specificity	85.0	97.6	83.3	79.5	97.6	10.3
False positives (<i>n</i>)	6	1	7	8	1	35
False negatives (<i>n</i>)	4	21	6	26	8	4
Group 1 (sealed with clear Vue) (<i>n</i> = 60)						
PPV	96.8	100.0	87.2	83.9	100.0	72.2
NPV	90.5	58.8	71.4	53.6	80.0	50.0
Sensitivity	93.8	65.0	85.0	66.7	87.5	92.9
Specificity	95.0	100	75.0	75.0	100.0	16.7
False positives (<i>n</i>)	1	0	5	5	0	15
False negatives (<i>n</i>)	2	14	6	13	5	3
Group 2 (sealed with Helioseal) (<i>n</i> = 60)						
PPV	88.1	97.0	95.0	90.0	97.3	65.5
NPV	88.9	74.1	100.0	55.2	87.0	50.0
Sensitivity	94.9	82.1	100.0	67.5	92.3	97.4
Specificity	76.2	95.2	90.0	84.2	95.2	4.8
False positives (<i>n</i>)	5	1	2	3	1	20
False negatives (<i>n</i>)	2	7	0	13	3	1

^aOptical coherence tomography (OCT), laser fluorescence (LF), International Caries Detection and Assessment System (ICDAS-II).

^bPPV, positive predictive value; NPV, negative predictive value.

TABLE 2. OCT, LF, ICDAS-II, and Radiograph Assessment of Sound (E0) and Early Carious Teeth (E1) Before and After Sealant Application

	Before sealant applied				After sealant applied	
	OCT ^a % (n)	LF% (n)	ICDAS% (n)	Radiograph% (n)	OCT% (n)	LF% (n)
Histopathogy identified as E0 and E1 (all teeth <i>n</i> = 56)						
E0 (<i>n</i> = 41)						
Scored same as histo	82.9 (34)	97.6 (40)	82.9 (34)	75.6 (31)	97.6 (40)	9.8 (4)
More carious than histo	17.1 (7)	2.4 (1)	17.0 (7)	24.4 (10)	2.4 (1)	90.2 (37)
E1 (<i>n</i> = 15)						
Scored same as histo	66.7 (10)	0	20.0 (3)	0	73.3 (11)	0
More carious than histo	26.7 (4)	20.0 (3)	40.0 (6)	40.0 (6) ^b	6.7 (1)	93.3 (14)
Scored as sound	6.7 (1)	80.0 (12)	40.0 (6)	60.0 (9)	20.0 (3)	6.7 (1)
Group 1 (ClearVue) (<i>n</i> = 30)						
E0 (<i>n</i> = 20)						
Scored same as histo	90.0 (18)	100 (20)	75.0 (15)	75.0 (15)	100.0 (20)	15.0 (3)
More carious than histo	10.0 (2)	0	25.0 (5)	25.0 (5) ^b	0	85.0 (17)
E1 (<i>n</i> = 10)						
Scored same as histo	70.0 (7)	0	30.0 (3)	0	70.0 (7)	0
More carious than histo	30.0 (3)	10.0 (1)	20.0 (2)	40.0 (4) ^b	10.0 (1)	90.0 (9)
Scored as sound	0	90.0 (9)	50.0 (5)	60.0 (6)	20.0 (2)	10.0 (1)
Group 2 (Helioseal) (<i>n</i> = 26)						
E0 (<i>n</i> = 21)						
Scored same as histo	76.2 (16)	95.2 (20)	90.5 (19)	76.2 (16)	95.2 (20)	4.8 (1)
More carious than histo	23.8 (5)	4.8 (1)	9.5 (2)	23.8 (5) ^b	4.8 (1)	95.2 (20)
E1 (<i>n</i> = 5)						
Scored same as histo	60.0 (3)	0	0	0	80.0 (4)	0
More carious than histo	20.0 (1)	40.0 (2)	80.0 (4)	40.0 (2) ^b	0	100.0 (5)
Scored as sound	20.0 (1)	60.0 (3)	20.0 (1)	60.0 (3)	20.0 (1)	0

^aOptical coherence tomography (OCT), laser fluorescence (LF), International Caries Detection and Assessment System (ICDAS-II).

^bRadiographs did not identify any enamel lesions (E1-E2), categorizing all lesions D1-3.

occlusal surfaces improved the specificity (SP) and PPV of OCT-based assessments, and modestly decreased sensitivity (SE) and NPV. Conversely, the presence of either dental sealant on the occlusal surface greatly improved LF SE, but dramatically reduced SP, PPV, and NPV.

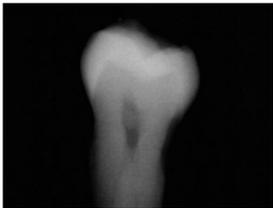
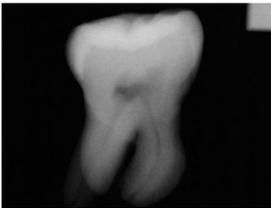
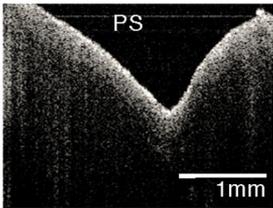
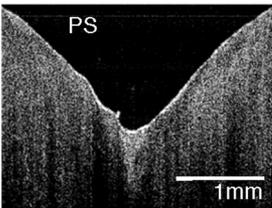
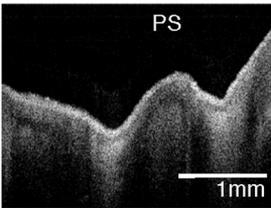
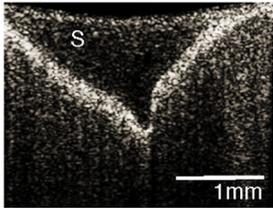
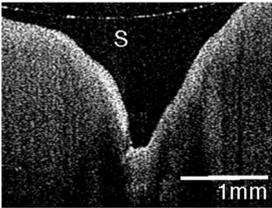
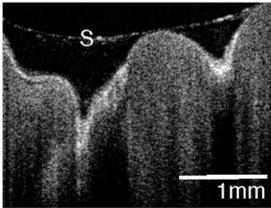
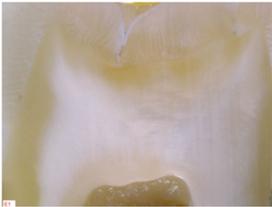
Table 1 shows pre-sealant application, OCT-based and ICDAS-II assessments demonstrated similarly good SE (94.0%; 92.3%) and SP (85.0%; 83.3%), and positive (91.3%; 91.1%) and negative (89.5%; 85.4%) predictive values on unsealed occlusal surfaces. Pre-sealant LF assessment demonstrated particularly high SP (97.6%) and positive predictive value (93.2%), but low SE (65.2%) and negative predictive value (65.6%). Pre-sealant radiograph assessment did not detect any E1 lesions, demonstrating generally low SE (67.1%), SP (79.5%), positive predictive value (86.9%), and particularly low negative predictive value (54.4%). These findings are consistent with previous studies [47]. Post-sealant OCT-based assessment demonstrated high SP (97.6%) and PPV (98.6%), a modest increase in the number of false negatives (8/70) from pre-sealant assessments, and modest reductions of SE (89.9%), NPV (83.3%), and the number of false positives (1/56). Conversely, post-sealant LF assessment demonstrated lower (SP) (10.3%), PPV (68.8%), and NPV (50.0%), a

modest decrease in the number of false negatives (4/79), with large increases in SE (95.1%) and the number of false positives (35/56).

Table 2 shows the OCT-based, LF, ICDAS-II and radiograph assessments and post-sealant OCT-based and LF assessments of unsealed sound (E0) and very early carious (E1) teeth compared with the gold standard. Pre-sealant OCT-based assessments correctly identified 82.9% of sound teeth and 66.7% of early caries, whilst pre-sealant LF assessment correctly identified 97.6% of sound teeth but no early caries, mischaracterizing 80% of early caries as sound and 20% as more severe caries. Post-sealant OCT-based assessment correctly categorized 97.6% of sound and 73.3% of early carious lesions compared with post-sealant LF assessments which correctly categorized 9.8% of sound but no early carious lesions, mischaracterizing 93.3% of early carious lesions as more severe than staged by the gold standard.

Representative images of one subject from histological categorizations E0, E1, and E2 are shown in Table 3. Table 3 compares photographs, radiographs, OCT images pre- and post- sealant, and histologic images of selected sample teeth determined by ICDAS-II to be E0, E1, and more severe than E2.

TABLE 3. Comparison of Photographic, Radiographic, OCT, and Histologic Images

	ICDAS-II E0 OCT <2.9 (sample 21)	ICDAS-II E1 OCT ~2.9 (sample 84)	ICDAS-II E2+ OCT <2.9 (sample 72)
Photo (ICDAS)			
Radiograph			
OCT image before sealant application			
OCT image after sealant application			
Histology			

PS, shadow from probe sheath; S, sealant.

DISCUSSION

Although in this study sealants were used that are specifically recommended as compatible with LF, this modality was found to be inconsistent in its assessments of caries under sealants, misdiagnosing caries as sound and sound teeth as carious [12,15,48]. This finding is consistent with other studies which found that sealant material attenuates LF signals, reducing diagnostic accuracy [49],

doing so to a lesser degree in unfilled sealants than in densely filled materials. Moreover, sealants themselves may exhibit intrinsic fluorescence, confounding the diagnostic signal and perhaps contributing to the low SP of LF when sealants are present [50]. The recommended cutoffs-range for interpreting LF measurements add to the uncertainty of the diagnostic decision [51]. The cutoffs used in this study, 0–7 indicating sound (E0) and 8–14 indicating demineralized/early caries (E1), were chosen to

provide maximal sensitivity and specificity [46]. These cutoffs resulted in LF demonstrating a higher SP and but lower SE than other studies which used 0–11 to indicate sound or demineralized areas and 12–16 indicated enamel caries [51]; or 0–9 to indicate sound and 10–17 to indicate enamel caries [52]. Though a tooth identified by LF as sound is likely sound teeth identified by LF as carious were over 90% more severe, despite our using cutoffs to maximize SP and SE. LF would result in unnecessary dental treatment and mischaracterize truly effective non-invasive and minimally invasive caries prevention and management strategies as ineffective [49].

ICDAS-II was identified as a reliable tool for evaluating the occlusal surfaces of natural, unsealed teeth [13], however it is not useful when sealants are present because of the need to closely examine the naked tooth surface visually, under carefully controlled conditions. As described in other studies, radiographs were unable to detect early occlusal enamel caries, regardless of the presence or absence of sealants [12,38,50,53,54].

This study confirmed the findings of previous research that OCT-based imaging combined with a simple diagnostic algorithm is able to accurately assess the severity of natural early caries in the absence and presence of dental sealants [6,35,55]. Visual assessments, LF and radiographs are less able to do so with a lesser degree of accuracy. The numerical OCT-based assessments demonstrated excellent sensitivity (SE) and specificity (SP). Areas of interest with a log of BSLI below 2.9 were accurately identified as sound locations regardless of whether sealant was present or not. Over 90% of sound and early caries sites under dental sealants were diagnosed accurately versus the gold standard, histology. The findings of this study are significant because integrating a numerical value into OCT imaging may address a critical barrier to use of OCT into clinical practice—clinicians' difficulty interpreting OCT images to assess caries depth [56]—despite the evidence of OCT's value [9,10,12,13,25–33]. This capacity could improve caries management and strengthen the use of sealants and other preventive measures by enabling clinicians to detect potential failure and caries progression quickly and accurately. Moreover this capability would permit direct, inexpensive quick and effective monitoring, and evaluation of management strategies in defined at risk populations.

In this study, a prototype laboratory SS-OCT system was used. Several commercially available mobile OCT systems are approved for dental use by trained personnel, even in a non-dental environment, requiring only a source of electricity. A simple software algorithm can easily be added to existing computer systems to facilitate OCT-based assessments' integration into electronic medical record systems. The use of a numerical output in addition to the OCT image improves diagnostic assessments particularly in clinical situations even following calibration [57]. Although ICDAS-II was able to accurately assess caries severity in this study. ICDAS-II may be less accurate in a traditional clinical situation with non-experts [58], who demonstrate much lower diagnostic accuracy

[58]. While ICDAS-II training is available online (<https://www.icdas.org/courses>), it but does not calibrate users in a difficult and multi-factorial evaluation process. Another challenge in a non-dental screening setting is LF and ICDAS-II both require that teeth be air dried for assessment. OCT can be used without air drying, since teeth can be imaged after being wicked dry as in this study. Thus OCT imaging is eminently suitable for community dentistry in non-traditional settings or teledentistry, facilitating the monitoring of clinically suspicious surfaces over time, even by different providers, and at different locations. This capacity becomes particularly valuable in communities where there is limited access to dental care, where vulnerable or disabled populations are unable to receive care in traditional dental care facilities, or for individuals whose dental treatment is particularly complicated or difficult (e.g., hemophilia, special needs). The initial expense of investing in an OCT system may be counterbalanced by quicker and more accurate dental diagnosis, resulting in more effective prevention and less intervention. Communication between clinicians in situations where different clinicians may be involved in patient care, and a valuable benchmark for quality assurance may be some of the additional benefits of this approach [59]. Clinical studies are now indicated to translate these *ex vivo* data to the clinical environment.

CONCLUSION

OCT-based imaging combined with a simple diagnostic algorithm can accurately assess the severity of natural early caries on occlusal surfaces in extracted teeth both in the absence and presence of dental sealant. The findings of this study support the clinical use of OCT imaging for assessment and monitoring progression of early non-cavitated caries lesions on occlusal surfaces including areas under dental sealants.

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