Optical Coherence Tomography -A Next Generation Diagnostic Imaging Tool in Periodontics and Oral Implantology

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Abstract: The conventional model of assessing periodontal disease involves a clinical examination to screen for inflammation-related signs, the presence of supra- and subgingival calculus, and periodontal probing to estimate bone loss.Traditional periodontal probing is prone to errors during its execution and fails to identify periodontal disease in the subclinical stage, despite its low cost, widespread use, and acceptance in the clinical setting.The use of alternative techniques like optical coherence tomography has sparked attention owing to the need for an early diagnosis approach and for monitoring periodontal tissues with improved precision, sensitivity, and noninvasiveness.A novel technique for noninvasively examining the interior tooth and soft tissue microstructure is optical coherence tomography. The discipline of dentistry has discovered the value of optical coherence technology (OCT), which has recently grown in relevance in the fields of medicine and research.In the field of periodontics, it has recently been demonstrated to be effective to assess gingival health, periodontal pocket, and peri implant conditions beforehand, making the treatment less challenging considerably before there is significant damage to the tooth structures.Much research is being done to improve the clinical application of OCT in dental medicine, which is anticipated to be a revolutionary prospective next generation diagnostic imaging tool. This review article focuses on the fundamentals, principles, and several research proving the value of OCT in the domain of Periodontics and implant dentistry.

Index Terms: Optical Coherence Tomography,Non-Ionizing,Periodontal Pocket, Periodontal Probing,Periodontal Disease, Diagnosis, Periodontal Defect,Gingival Tissue,Oral tissue,Optical Imaging, Periodontitis,Periodontal Inflammation.

I. INTRODUCTION

The purpose of periodontal diagnostic methods is to offer the practitioner meaningful information on the type, location, and degree of periodontal disease; this information can be used as a foundation for the planning of treatment and disease monitoring. For locating locations of active disease, making a diagnosis, formulating a treatment plan, quantitatively tracking a patient's response to therapy, and gauging the degree of vulnerability to further disease progression, traditional diagnostic techniques are frequently insufficient.[1]

Early in the 1990s, the revolutionary diagnostic tool optical coherence tomography (OCT) was developed. [2] The use of optical coherence tomography (OCT), a non-invasive imaging technique, is growing in a number of medical specialties, including dentistry. It can deliver micrometric resolution cross-sectional pictures of both hard and soft tissues. OCT images are produced by assessing the intensity and time delay of the reflected or backscattered near-infrared light from the tissue structure using the low coherence interferometry principle. OCT's quick acquisition speed allows it to produce in situ images of tissues that are nearly real-time or video rate. [3]

With an imaging capability of 1-3 mm depth into tissues and resolution that is almost identical to high magnification optical microscopy, OCT allows for the collection of volumetric data (such as epidermal thickness) at a microscopic level. [2]

The generation of tissue slices using optical coherence tomography is non-contact and non-invasive. The introduction of Fourier-domain (FD) methods, which offer a noticeable boost in sensitivity compared to conventional (TD)-OCT, has revolutionised OCT in recent years. Several functional OCT systems, including Doppler OCT, polarisation sensitive OCT, endoscopic OCT, and acoustic OCT, have been described for new biomedical research applications over the past ten years. [2]

Due to portability limitations and its high initial cost, OCT has primarily been employed in dentistry as an experimental tool rather than a diagnostic tool. OCT is a cutting-edge imaging equipment that can help dentists make better diagnoses by delivering non-invasive, real-time, high-resolution images without the use of ionising radiation. [3]

It has been used to quantify biologic width, peri-implant tissues, clinical attachment loss, gingival thickness, and pocket depth in the area of periodontics. This method differs from others in that it can distinguish minute changes in structural anatomy in real time, allowing the doctor to detect disease earlier than with other imaging diagnostics. [4]

II. HISTORY

In 1971, Duguay made the initial suggestion that biological tissues may be imaged using light and optics. In 1989, Fujimoto used OCT to image the retina of the eye. In 1993, Fercher et al. released the first in vivo OCT photographs. OCT was patented in 1994 by Carl Zeiss Meditec, Inc. of Dublin, California.The first commercially available OCT, called OCT 1000, was marketed in 1996 and then OCT 2000 in the year 2000. [5]In 1998, Colston et al. published the first in vitro pictures of dental hard and soft tissues in a pig model. They created a prototype OCT and took pictures of periodontal tissues from three pigs. Otis et al. first suggested OCT 2 imaging for dental uses in 2000. [6] The first in vivo spectral-domain (SD)-OCT images were presented by Wojtkowski et al in 2001.The US Food and Drug Administration (FDA) authorised the clinical use of SD-OCT systems in 2002. [5] The first in vivo dental images were shown by Feldchtein and colleagues, who also showed how OCT could be used to see the gingiva and hard palate mucosa. [7]

III. PRINCIPLE

The OCT operates on the Michelson's Interferometer principle. The beam splitter separates the light from the source into two equally energy beams, one of which strikes Mirror 1 (the reference arm, which is fixed), and the other beam strikes Mirror 2. (sample arm which is mobile and where we place the sample). After striking the mirrors M1 and M2, these two beams are reflected in the same direction with a minor deviation, combining at the coupler to generate an interference pattern that will be transmitted to the photoelectric device for image generation.The type of interference pattern that is generated—either constructive or destructive interference—determines how an image is formed. When the wavelengths of the two reflected beams are similar, constructive interference takes place, leading to the generation of an image, however when the wavelengths differ, destructive interference takes place and no image is created. [4]

IV. WORKING OF OCT

The interference of two partially coherent light beams—the reference beam and the probe beam—emitting from a single source forms the basis of optical tomography. A partially coherent light source, an imaging apparatus, a measurement head, a module of data processing and picture production, as well as a computer control system, are the five fundamental modules that make up the modular OCT device. The axial resolution and depth of the light beam in the device depend on the light source that is being used.The system's main component is the OCT imaging apparatus module. For light waves, biological objects like tissues and organs are the centres because of their non-uniform distribution of refractive indices. The sites at which the refractive index changes can be found by analysing interference signals. These sites are located along the probe beam's propagation direction.

An A-scan is a graph that shows the power density of the reflected wave as a function of the location of the reflective point, which is the wave's source. Sagittal scans of the item are provided by B scans, while images with a constant depth are provided by C scans. A two-dimensional representation of the test object's section is produced by combining measurement results that are all in one plane (many parallel directions of the probe beam).

Interferometric distance measuring devices are used to localise the boundaries of layers with varying refractive indices, or to calculate the waveform of refractive index changes as a function of light beam penetration depth. It makes use of the capacity for overlap among light waves. This characteristic is reliant on the coherence of light. Light coherence comes in two forms: spatial, which describes the phase correlation of wave sequences produced by various points of the light source, and time, which describes the phase correlation of wave sequences produced by a single point of the light source at various times. The Michelson interferometer is used to look at the time consistency of light.

The light wave divides into two beams when it strikes the semi-transparent mirror, or BS (beam splitter). The movable mirror M1 reflects the light source (LS), which after passing through BS changes direction to perpendicular and then, without changing direction, travels through BS once more and reaches the screen D. (detector). The primary beam goes through BS without changing directions, creating a second beam that reflects off of the fixed mirror M2, changes directions while passing through BS to become perpendicular, and finally falls on screen D.An interference pattern is created by the beam striking the screen. The system's main component is the OCT imaging apparatus module. Any measuring tool with high sensitivity and resolution that can measure backscattered or reflected light qualifies. Also essential are devices that allow for lossless signal transmission. The measuring head and the system for bringing the probe beam to the test structure are further components of the OCT system.Depending on the area of medicine for which they are intended, they come in a variety of shapes. The entire OCT scanner is under the supervision of the computer system. It makes it possible to synchronise the operation of every component and control the interferometer's reference arm scanning. Furthermore, it enables real-time display of measurement data as well as communication between the apparatus and the image processing block. [2]

V. MAIN CHARACTERISTICS

1. OCT imaging uses wavelengths between 600 and 2,000 nm, where the primary components of tissue—water and pigments—exhibit low absorption.
2. The optical spectrum line width and coherence length should be larger in order to attain great depth resolution.
3. For interference to occur, there must be a precise phase agreement between the interfering waves. Single scattered photons work better for this than multiple scattered photons since the event loses phase information as the number of photons rises.
4. The weak signal in the object arm, backscattered or transmitted through the tissue, is magnified by the powerful signal in the reference arm because photodetection at the interferometer output includes multiplication of the two optical waves. This explains why OCT is more sensitive than confocal microscopy, which can only capture images of a depth of 0.5 mm in the skin, for example.
5. Diffraction is used to determine the transverse resolution because OCT is designed around a confocal microscope.
6. The strength of the source in modern systems is significantly below the American National Standards Institute (ANSI) threshold for tissue damage, making dental OCT imaging safer. In comparison, the ANSI threshold for skin injury from a source with a 1.3 mm wavelength is 96 mW and, assuming 8 hours of continuous exposure, it is a thousand times lower than the standard.
7. Instantaneous, near-microscopic views of the subsurface can be obtained.
8. Imaging of tissue morphology in real time.
9. No sample or subject preparation.
10. No contact with the patient.
11. Ionizing radiation is absent.[5]

VI. ADVANTAGES

1. A solution with high depth and cross section.
2. Non-invasive and contact-free operation.
3. Ability to provide visual contrast that is based on function.

4. No risk of radiation.
5. OCT supports early oral disease diagnosis.
6. Real-time monitoring of both hard and soft tissues is made possible by OCT.
7. High resolution and penetration depth, allowing for the imaging of both normal and pathological alterations to the oral mucosa.[6]

VII. DISADVANTAGES

1. Restricted penetration depth in material that scatter light.
2. As OCT typically has a scanning range of several millimetres, numerous images would be required to scan an entire lesion.
3. The image acquisition time for OCT is longer.[6]

VIII. TYPES OF OCT

1. Time Domain OCT (TDOCT)
2. Spectral Domain OCT (SDOCT)
3. Functional OCT
4. Polarisation Sensitive OCT
5. Differential Absorption OCT
6. Doppler OCT
7. En-Face OCT or Full-Field OCT

Time Domain OCT (TDOCT)

The reference arm's path length is time-scanned in TDOCT. Interference, or a succession of dark and brilliant fringes, can only occur when the optical path difference (OPD) is within the light source's coherence length. As the OPD is changed, the envelope of this modulation shifts, with the peak of the envelope corresponding to path-length matching.

This kind of OCT is covered in a number of reports. The periodontal ligament alterations brought on by orthodontic forces and orthodontic interfaces have been observed using TDOCT.

Spectral Domain OCT (SDOCT)

SDOCT measures the spectrum at the low coherence interferometer's output. The depth scan (A-scan), which is determined by a Fourier-transform from the acquired spectra without moving the reference arm, is possible due to the Fourier relation (Wiener-Khintchine theorem between the auto correlation and the spectral power density). SDOCT significantly increases imaging speed because all depths are measured in a single step. Compared to TDOCT, SDOCT also has a better signal-to-noise ratio. SDOCT can also be classified into camera-based, Fourier domain (FD) OCT and swept source (SS) OCT.

A narrow band optical source with a tunable frequency is employed in SSOCT. They use point photodetectors. While the axial range is constrained by the source's coherence length, the depth resolution is inversely related to the tuning bandwidth; the smaller the line width, the greater the axial range.

In FDOCT, a dispersive detector is utilised to acquire the spectrum from a broadband optical source. The axial range is constrained by the spectrometer resolution, whereas the depth resolution is determined by the optical source bandwidth.

Functional OCT

Functional OCT offers depth-resolved data on the backscattered signal's reflectance, phase, and polarisation. Here, the signals are indicative of functional alterations in the affected tissue or organ, which typically occur before morphological abnormalities and aid in early identification. Functional OCT examples include polarization-sensitive (PS)-OCT, spectrometric OCT, differential absorption OCT, and Doppler OCT.

Polarisation Sensitive OCT

By examining variations in the polarisation state of the backscattered probe light beam, PS-OCT can identify and measure the polarisation characteristics of the tissue. Birefringent structural components in the target tissue can be found using the information provided by polarisation sensitive OCT images. As a result, changes to the target's structure, functioning, or integrity may be associated with the images obtained. For instance, skin collagen gets denatured by thermal damage, and polarisation sensitive OCT can detect these changes in the collagen.

Differential Absorption OCT

The system in differential absorption OCT employs two channels, each of which operates at a distinct wavelength. One wavelength is chosen for low absorption, and the other is chosen for wavelengths near to the absorption peak of the component being examined.

Doppler OCT

Biological fluids are monitored or measured using Doppler OCT. The produced image is based on the depth-resolved profile of the vessel's flow velocity, with resolution set by the source's coherence length.

En-Face OCT or Full-Field OCT

An OCT variant based on white-light interference microscopy is called en-face OCT. In place of a complicated laser-based source, it uses a straightforward halogen lamp to produce ultrahigh resolution images in three dimensions (3D), which is an alternative to the traditional OCT approach. Here, the tomographic images are created by combining interferometric images that were simultaneously captured by a detector array, such as a CCD camera, in the en-face (transverse) orientation. [8]

IX. APPLICATIONS IN PERIODONTICS AND ORAL IMPLANTOLOGY [9-45]

Table 1

S.NO.	TYPE OF OCT	HUMAN	ANIMAL	IN VITRO	AUTHOR	YEAR	RESULTS
DENTAL BIOFILM MONITORING							
1.	Cross polarization optical coherence tomography system (CP-OCT)	Plaque samples of pediatric subjects			Chen et al.	2012	CP-OCT has the ability to non-destructively monitor biofilm growth and elucidate the growth characteristics of these microbes on different dental material compositions. CP-OCT was able to quantify the mass of the biofilm by measuring the overall depth-resolved scattering of the biofilm.
2.	Spectral Domain Optical Coherence Tomography (SD-OCT)	25 patients			Negrutiu et al.	2016	The biofilm network was dramatically destroyed after the professional dental cleaning. OCT noninvasive methods can act as a valuable tool for the 3D characterization of dental biofilms.
3.	Custom flow cell system integrated with a real time cross polarization optical coherence tomography system	.		Tooth like surfaces	Englund et al.	2017	This novel CP-OCT flow cell assay has the potential to examine rapid interactions between antibiofilm agents and

							tooth like surfaces.
4.	Hand held OCT system	Healthy volunteers and subjects with gingivitis and sufficient plaque were recruited.			Won et al	2020	OCT has a strong potential to display and assess dental plaque and gingiva in a clinical setting.
DENTAL CALCULUS DETECTION							
5.	Fiber-probe swept-source optical coherence tomography (SS-OCT)			Human teeth including molars and premolars (n =8)	Kao et al	2015	With its all-fiber-based implementation , miniature lightweight fiber-probing optics, and high discriminatory capacity provided by simultaneous SD measurements, this compact and portable system may be an efficient tool for detecting subgingival calculus. The 3D OCT scanning design and flexible projectile processing are also useful in image registration for OCT images from multiple measurements, such as monitoring of calculus lesions after treatment.
6.	Swept-source optical	1 Human subject		Six extracted	Tsubokawa et al	2018	the SS-OCT system may

	coherence tomography (SS-OCT)			teeth with subgingival calculus and without apparent caries lesions or defects on the root surface			constitute a periodontal diagnostic tool with the capacity to detect subgingival calculus and root cementum.
7.	Spectral-domain optical coherence tomography			Ten teeth with calculus on the root surface	Krause et al	2019	Calculus on the root surface can be displayed by SD-OCT, which therefore may be suited as imaging technology for subgingival calculus in periodontal pockets.
IMAGING OF PERIODONTAL TISSUES/ORAL TISSUES							
8.	Prototype dental OCT system	Healthy adults			Otis et al	2000	OCT images exhibit microstructural details that cannot be obtained with current imaging modalities. Using this new technology, visual recordings of periodontal tissue contour, sulcular depth and connective tissue attachment now are possible. The internal aspects and marginal adaptation of porcelain and composite restorations can be visualized.
9.	Cross-polarization optical	Cheek Mu cosa specimens from 33 patients including 17 patients			Gladkova et al.	2012	The OCT signal SD in cross-polarized images reflects

	coherence tomography	with Crohn's disease (CD), 12 patients with ulcera tive colitis (UC), 2 patients with oral mucosa lichen ruber planus (LRP), and 2 patients with chronic aphthous stomatitis					two boundary conditions of collagen disorganization, namely, loss of fibre properties at active inflammation which attenuates the signal and fibrosis that occurs due to synthesis of a new remodeled collagen which amplifies the OCT signal.
10.	Fourier Domain OCT		Five fresh porcine jaws		Mota et al.	2015	Regarding the ability of the two OCT systems to visualize periodontal structures, the system operating at 1325 nm shows a better performance, owing to a longer central wavelength that allows deeper tissue penetration. The results with the system at 930 nm can also be used, but some features could not be observed due to its lower penetration depth in the tissue.
11.	Time-domain optical coherence tomography			Extracted tooth samples along with gingival tissues	Damodaran et al.	2015	The conventional time domain OCT system acquisition speed is limited by the speed of the mechanical scanning system. In order to overcome this issue, a novel electro-optic-based scanning system is

							proposed and demonstrated.
12.	Swept Source OCT	23 periodontally healthy patients			Fernandes et al.	2016	OCT has the potential to be a reliable tool for in vivo periodontal tissues evaluation and for reproducible sulcus depth measurements in healthy sites. Further technological advances are required to reduce the procedure time and promote evaluation of posterior oral regions.
13.	Swept source OCT	Human enamel, human cortical bone, human trabecular bone	Rat masseteric muscle and fatty tissue		Salehi et al.	2017	These OCT features can reliably differentiate between a range of hard and soft tissues and could be extremely valuable in assisting dentists for in vivo evaluation of oral tissues and early detection of pathologic changes in the tissues.
14.	Swept-source optical coherence tomography (SS-OCT)		Five beagle dogs		Park et al	2017	Dental OCT as used in this study was able to generate high-resolution, cross sectional images of the superficial portions of periodontal structures.

15.	Hand held optical coherence tomography	Healthy 24-year-old male and 25-year-old female			Tsai et al	2017	The developed handheld OCT system has been demonstrated for in vivo oral cavity imaging, enabling the identification of the different structures and observation of the microcirculation features of various oral mucosal types.The developed OCT system is a promising tool for noninvasive imaging of oral mucosae.
16.	State-of-the-art swept-source OCT (SS-OCT) and OCT angiography (OCTA).	Human gingiva			Le et al	2018	Significant structural and vascular differences between the two extreme gingival biotypes (ie, thick and thin gingiva), and demonstrated special features of vascular arrangement and characteristics in gingival inflammation
17.	Swept Source OCT	147 vestibular dental sites from 49 teeth in 14 patients aged 18-65 years old (6 males and 8 females)			Fernandes et al	2019	The study evidenced the ability of OCT in the identification of periodontal structures and alterations, being an important non-invasive complement or even alternative for periodontal probes for treatment followup.

18.	Optical Coherence Tomography	Two human subjects			Lai et al	2019	This work proposed a non-invasive framework for frequent periodontal inspection by estimating the gumline and alveolar line of the target region using optical coherence tomography. Our system optically rectified the scanning results for precise measurement.
19.	Swept-source optical coherence tomography (SS-OCT)	Five healthy volunteers (3 males and 2 females			Lee et al	2019	The gingival sulcus depth could be quantitatively measured by using the swept-source OCT system with the developed image classification algorithm as well as revealing a structural visualization, which ultimately confirmed the potential applicability for gingival sulcus depth real-time assessment.
20.	Swept source OCT system	11 patients (six female and five male patients)			Kim et al	2022	The CNN models were applied to automatically segment the periodontal structures of the tooth enamel and the alveolar bone and to

							quantitatively measure the ABL by automatically detecting the CEJ and the ABC in OCT images. The CNN models showed high segmentation accuracies in the tooth enamel and alveolar bone regions, and the ABL measured by detection results from CNN predictions demonstrated high correlation and reliability with the ground truth in OCT images.
GINGIVAL DISEASE/PERIODONTAL DISEASE/PERIODONTAL INFLAMMATION/PERIODONTAL POCKET ASSOCIATED							
21.	Prototype optical coherence tomography ~OCT system		Porcine periodontal tissues		Colston et al	1998	The images clearly show the enamel–cementum and the gingiva–tooth interfaces, indicating OCT is a potentially useful technique for diagnosis of periodontal diseases.
22.	Swept-source OCT system		Porcine sample		Kim et al.	2017	OCT was able to visualize periodontal pockets and show attachment loss. By calculating the calibration factor to determine the accurate axial resolution, quantitative standards for measuring periodontal pocket depth can be established regardless of the position of

							periodontal pocket in the OCT image.
23.	Swept-source optical coherence tomography (SS-OCT).		Mandibles of the porcine model		Kang et al	2017	OCT could automatically detect the position of various cracks in the OCT images and visualize deep periodontal pockets. By calculating the calibration factor to determine the accurate axial resolution, a quantitative standard measuring sulcus depth can be established regardless of the position of the gingival sulcus in the OCT image. We were able to automatically detect the position of various cracks in the OCT images. Therefore, the detection capability of SS-OCT images may make SS-OCT a useful diagnostic tool for dental care.
24.	OCT	Gingival samples were collected from three types of patients: patients with periodontal disease; patients with periodontal disease and a systemic comorbidity;periodontal and systemic healthy patients.			Surlin et al	2018	OCT has proven that in an in-vitro environment it can be a useful tool for the assessment of periodontal inflammation in gingival samples of periodontal patients.

25.	Optical coherence tomography and light-induced autofluorescence (LIAF).	Gingivitis case study			Le et al	2021	Under OCTA, the angiogenic sites saw a proliferation of vessels, followed by a shrinkage of vessels for a period of approximately 6 days after the peak proliferation. In the nonangiogenic site, vessels increased in size but not as dramatically, then reduced gradually over a period of approximately 7 to 8 days. Autofluorescence imaging (LIAF) demonstrated the presence of mature plaque and calculus. All the observations are consistent with previous literature in regard to the mechanism of host response, and the period of time required for gingivitis resolution. The result of this study illustrates that an immediate

							application of the OCT-LIAF system may include a study of how gingival inflammation correlates with changes in the properties of blood vessels (obtained from OCTA), gingival thickness (obtained from OCT), and red fluorescence due to the accumulation of biofilm.
26.	Raman microspectroscopy (RMS) and micro-optical coherence tomography (μOCT)	Gingival biopsies from eight subjects with healthy periodontal tissues or with Stage II to IV periodontitis			Saggu et al	2022	Results suggest that combined RMS/μOCT chairside imaging may distinguish between healthy and diseased sites by evaluating marginal periodontal morphological and biochemical features.
PERIODONTAL REGENERATION THERAPY							
27.	Swept Source OCT	Young female patient			Fernandes et al.	2016	OCT is an efficient method in the evaluation of gingival regeneration .
PERIODONTAL THERAPY FOLLOW UP							
28.	Swept-Source OCT device	1 Human subject			Graça et al	2019	OCT was found to be a promising

							approach for the professional evaluation of aesthetic oral rehabilitation, as it was capable of generating images that enabled the analysis of gingival recovery and the adhesive interface.
PERIODONTAL LIGAMENT CHANGES WITH ORTHODONTIC TREATMENT							
29.	OCT		Four white rats		Na et al	2008	These results support the clinical dental application of OCT for monitoring the ligament changes during orthodontic procedures. The real-time imaging capability of OCT, together with its high resolution, has the potential to help dentists with in vivo orthodontic treatments in human subjects as well.
30.	Time-domain OCT system		6 white rats		Baek et al	2009	This preliminary study shows the possible evaluation and prediction of precise tooth responses under orthodontic forces by using real-time OCT.
DENTAL IMPLANTS AND ITS ASSOCIATED PERIODONTAL DISEASES							
31.	Near infrared absorption (NIR) and optical coherence tomography			*Ex vivo* human jaw bone.	Weber et al.	2013	The proximity to the neurovascular bundle can be tracked in real time in the range of a few millimeters with NIR signals, after

							which higher resolution imaging OCT to provide finer ranging in the submillimeter distances.
32.	Dental SS-OCT		Fresh porcine periodontal tissues		Kikuchi et al.	2014	OCT appeared as an effective tool for evaluating the misfit of implant-abutment under thin layers of soft tissue.
33.	Prototype dental OCT imaging system		Edentulous ridges of anesthetized Göttingen female minipigs		Bordin et al.	2016	Development of clinical applications of OCT imaging for early diagnosis of mucositis could lead to therapeutic interventions to reduce one of the causes of implant failure.
34.	OCT system		Mandibles of pigs		Sanda et al	2016	Cement remnants at the submucosal area can be detected in some cases, which can be helpful in preventing peri-implant diseases. OCT could have potential as an effective diagnostic instrument in the field of implant dentistry as well.
35.	OCT System		Porcine mandibles		Kim et al	2018	OCT images can be used to visualize the peri-implant bone level and to identify bone defects. The potential of quantitative

							non-invasive measurements of the amount of bone loss was also confirmed.
PERIODONTAL DISEASE AND SYSTEMIC INVOLVEMENT							
36.	OCT OCS 1300SS device	Gingival tissue samples obtained from patients who were divided into three groups – P (periodontitis), non-alcoholic fatty liver disease(NAFLD+Periodontitis), (NAFLD+periodontitis and H (healthy) groups			Surlin et al	2021	After comparing the OCT analysis results obtained for the three groups of patients, we can consider that non-alcoholic fatty liver disease (NAFLD)may be an aggravating factor for the inflammation of periodontal disease.
37.	Dynamic optical coherence tomography , laser perfusion, and capillaroscopic video imaging.	Gingival inflammation induced in 21 healthy volunteers			Townsend et al	2022	After 3 weeks of plaque accumulation, there was wide variation in microvascular reactions between the participants. Reduced capillary flow was associated with the development of venular capillaries in some individuals. This is noteworthy, as an early increase in venous capillaries is a key vascular feature of cardiovascular disease, psoriasis, Sjögren syndrome, and rheumatoid arthritis—diseases with a significant association with the

							development of severe gingival inflammation, which leads to periodontitis.

X. FUTURE POTENTIAL

Enhancing the contrast between healthy and diseased tissues should be worked upon.

Creating imaging software and algorithms for image analysis, contrast measurement, and image registration for real-time simultaneous processing and analysis of images should be the focus of future research.

XI. CONCLUSION

OCT is a vital tool for the in vivo and in vitro examination of oral tissues. OCT enables soft-tissue imaging, which is crucial for treating periodontal diseases, as it is hard to examine direct clinically, and provides excellent opportunities

for early identification of lesions in the oral mucosa. After addressing the issues relating to the availability and quality of equipment, OCT will become the method of choice in contemporary dental diagnostics because it provides tissue

sections in a non-contact and non-invasive manner and enables real-time tissue imaging in situ without the need for biopsy, histological procedures, or the use of X-rays.

Considering the benefits of OCT as described in this review, it is recommended that handheld OCT devices be developed further, particularly for dental applications, to increase their viability, lower their costs, and most importantly

attract researchers who would maximise their usage in clinical settings.

OCT is a cutting-edge diagnostic tool that has the potential to transform periodontal examination.In general, it is a useful technique for examining and evaluating oral hard and soft tissues. OCT imaging's special abilities, on the other

hand, imply that it has the potential to significantly affect the clinical management and diagnosis of periodontal diseases as well as lower the failure rate of periodontal treatments by saving time and resources.

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