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REVIEW ARTICLE

Diagnosis of Early Dental Caries by Traditional, Contemporary and Developing Imaging Methods

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Abstract

Dental caries is an important problem for human health which is frequently seen under clinical conditions and also progresses slowly, causes severe pain and even tooth loss, and affects the quality of life. Especially in pediatric patients, with the early detection of caries, treatment procedures can be performed with uncomplicated methods. In today's dentistry; preventive applications and minimally invasive approaches are gaining importance, and early diagnosis of initial caries lesions is very important for minimally invasive dentistry. With the development of technology, many new methods are being introduced to ensure the early diagnosis of dental caries. In this review, conventional, contemporary, and developing approaches used in the detection of dental caries will be presented.

Key words: dental caries; diagnosis; imaging methods; radiographical examination; tactile examination

Introduction

Tooth decay, one of the most common infectious diseases in humans around the world, is caused by diet, carbohydrates, and bacteria, resulting from the interaction of various factors.[1–3] Dental caries is an important problem for human health which is frequently seen under clinical conditions and also progresses slowly, causes severe pain and even tooth loss that affects the quality of life.[2,4] Although by a clear examination with dental mirror under dental unit light, pit, fissure, color changes and demineralization areas at the approximal surfaces can be determined, some of them may not have any visible changes.[5] In today's dentistry; preventive applications and minimally invasive approaches are gaining importance, and early diagnosis of initial caries lesions is very important for minimally invasive dentistry.[2] Conventional and contemporary approaches are of great importance in the early and advanced diagnosis of dental caries. Although it could be difficult to obtain sufficient information in the early period of a dental caries by conventional methods, with current approaches detection of caries would be more easy and necessary preventive and treatment procedures can be applied. With technological progresses, dentists should update their knowledge of conventional caries detection and caries criteria. In this review, conventional, contemporary, and developing approaches used in the detection of dental caries will be presented.

1. Conventional Methods

The subjective evaluation of caries by visual inspection and tactile sensation and its interpretation with radiographs are called traditional methods.[6]

1.1. Inspection and tactile examination:

Inspection and tactile examination are the most commonly used caries diagnosis method. It is an examination performed by using a dental mirror, light, and a probe to examine the entire tooth surface in detail after the teeth are cleaned and dried.[7–9] It is the earliest and most common method in dentistry; however, its objectivity and adequacy are questionable today.[7] Different classifications are used to provide standardization in inspection and examination by using a probe.[10,11] Although each classification has different scoring criteria, the main purpose of all classifications is to establish internationally accepted evaluation criteria and to provide clinicians, epidemiologists and researchers with an evidence-based caries detection facility.[12]

1.2. Radiolographical examination:

Although radiographical examination is the most frequently used as a supporting method in the diagnosis of caries, it should be kept in mind that clinical and the radiolographical evaluations are never

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sufficient.[5,13–15] Periapical and bitewing radiographs are widely used in clinical examination and diagnosis. The purpose of bitewing radiographs is to identify approximal carious lesions that cannot be detected on visual examinations.[9] It has been reported that radiographs are more sensitive than clinical examination in detecting approximal caries, evaluating the depth of occlusal caries lesions in dentin, and changes in caries lesions.[16,17]

2. Visual Techniques (Transillumination Methods)

With increasing concerns about the use of ionizing radiation, alternatives to bitewing radiographs have begun to be investigated for the diagnosis of approximal caries.[18] Transillumination is one of the oldest caries diagnosis methods.[19] It is a beneficial instrument that can be used especially in the diagnosis of approximal caries.[20] The transillumination method is based on the principle that carious and healthy tooth tissues have different light transmittance. Solid enamel consists of interlocking hydroxyapatite crystals and has a translucent structure.[21] Demineralization causes decomposition in the enamel structure. In such cases, photons of incident light are scattered, causing deterioration in the optical properties of the enamel. Decayed tooth structure traps the light and causes a decrease in light permeability compared to healthy enamel, so carious areas in the light-applied tooth appear as dark shadows in clinical examination.[22] In dentistry, the transillumination method has been a very encouraging method for the detection of caries and different technologies have been developed based on this principle.[19,20] The Fiber Optic Transillumination (FOTI) method, in which visible light systems are used, is the oldest transillumination system. Subsequently, the Digital Fiber Optic Transillumination (DIFOTI) system, in which the fiber optic transillumination method and digital recording systems are used together, was developed. After the development of fiber optics using visible light in early caries diagnosis, the Near-Infrared Light Transillumination (NILT) method, in which near-infrared light and digital camera systems are used together, has been developed for transillumination of teeth due to its ability to penetrate more deeply.[22,23]

2.1. Fiber Optic Transillumination Method (FOTI):

High-intensity visible light source (450 and 700 nm) can be easily applied anywhere in the oral cavity.[24] In the fiber optic transillumination method, high-intensity white light from the cold light source is applied to the buccal or lingual surface of the tooth with the help of a thin fiber optic tip.[25] In the FOTI system, different light refracting properties of healthy tooth tissue and decayed tooth tissues with changed mineral density is utilized.[24] Since decayed tooth enamel refracts light more strongly than healthy tooth enamel, it has a lower light transmission index.[26] Intact enamel may appear almost completely transparent due to the densely arrayed modified hydroxyapatite crystals, while dentin may appear orange, brown, or gray under enamel.[20,27] The most important advantage of FOTI is the absence of the risk of ionizing radiation. For this reason, it is thought that it may be appropriate for pregnant women and children.[28] As another advantage, it was emphasized that transillumination methods can be a valuable alternative in children who cannot cooperate during radiography.[29] In addition, its clinical application is simple and comfortable for the patient, it can be applied quickly, it does not require heavy and expensive equipment and is suitable for field studies as it is a portable and practical method.[30]

Although FOTI is a simple and economical method, its use has been limited due to its subjective nature, low sensitivity, inability to save illustrations and print out data.[31,32]

2.2. Digital Fiber Optic Transillumination Method (DIFOTI):

Digital Fiber Optic Transillumination (DIFOTI) is a computer-assisted method developed to complete the deficiencies of FOTI and created by combining FOTI and a digital camera where the image is viewed.[26] The fiber optic transillumination method is simple, but the DIFOTI method, in which digital imaging and FOTI are applied together, has been developed to eliminate its negative features such as the subjective evaluation, the inability to save the image, and the need for experience and careful examination.[24] In the DIFOTI system, the tooth is illuminated with a visible light source (450-700 nm wavelength) and the image of the unilluminated surface on the other side of the tooth is recorded with a digital electronic camera (CCD, charge-coupled device). The use of CCD enables the projection of snapshots, making it possible to compare changes in different exams over time.[33]

In images taken with DIFOTI, the caries lesion is observed as a black area due to the differences in the light reflectance properties of healthy and demineralized tissues.[31,34] By increasing the contrast between healthy and carious lesions, the characteristics of caries on occlusal, approximal and flat surfaces can be observed.[24]

The advantages of the DIFOTI method over radiographs include not using ionizing radiation, not needing a film, obtaining simultaneous results, and demonstrating higher sensitivity in detecting lesions that are not seen in the early period in vitro.[35]

2.3. Near Infrared Transillumination Method (NILT):

With today's technology, modifications of this technique have been developed, increasing the imaging quality and near-infrared light transillumination (NILT) systems have been introduced. This system is an enhanced version of DIFOTI. The main difference between these systems is that the DIFOTI system uses visible light (400-700 nm) while the NILT system uses invisible long-wave light (700-1500 nm). The biggest advantage of using longer wavelengths is that infrared light scatters less and allows it to penetrate deeper into objects. Caries detection methods using this system are based on the principle that light can easily pass through tooth enamel and reflect the contrast difference between carious lesions and healthy teeth. The NILT system also does not use ionizing radiation (X-ray) to visualize interproximal caries lesions like the FOTI and DIFOTI systems.[36,37]

With the NILT imaging system, the entire occlusal surface can be visualized and demineralization zones can be detected.

3. Optical Coherence Tomography

Optical coherence tomography is a non-ionizing imaging technique that can create cross-sections of biological tissues using 1310 nm infrared light.[9,38] It is a technique that enables the visualization of differences in optical characteristics of teeth and soft tissues with micron-level high-resolution images using near-infrared light (NIR).[39–44] Using a low-coherence light source and Michelson interferometry, cross-sectional images of the tissue are obtained.[43,45] The light reflected from the deep layers of the tissue shows a delay compared to the light reflected from the surface. OCT is based on imaging reflected light. However, like a camera, it not only acquires a two-dimensional image but also a depth dimension. This amount of delay between the lights reflected from the tissues is calculated.[46] The reflected rays are interpreted to produce images that represent the optical reflection of the tissue in the cross-sectional plane. With a prototype of OCT, first reported by Fujimoto in 1991, and developed by Colston et al., dental hard tissues could be imaged in vivo and in vitro.[43,47] There are different types, such as Polarization Sensitive Optical Coherence Tomography (PS-OCT), Cross-Polarization Swept Source Optical Coherence Tomography (CP-OCT), Swept Source Optical Coherence Tomography (SS-OCT), Spectral Domain Optical Coherence Tomography (SD-OCT/FD-OCT). OCT is used as a successful imaging technique in the diagnosis of initial carious lesions and the evaluation of remineralization. The place of OCT in dentistry clinical practice is increasing day by day, and studies on the clinical usability of a few prototype OCT probes continue intensively. The biggest advantages of OCT are its features such as easy acquisition and recording of images, instant image acquisition and non-invasiveness; It makes OCT an important alternative for caries diagnosis. Another benefit of this tomography technique is that it can be used safely in children and pregnant women.[44]

4. Electrical Conductivity Measurements

Each substance has unique properties and the electrical current is passed through any material when that material properties of the transmitted current and the flow of the material affects the degree of changes in the structure leads to differences in degrees. The fact that this situation is valid within the tooth structure has been effective in the development of electrical conductivity methods for caries detection.[48]. In this method, an electric current is used to diagnose caries based on the difference in electrical conductivity between the healthy teeth and carious lesions. Although the conductivity of intact enamel is limited, the conductivity of tooth enamel increases with increasing demineralization. However, since solid dentin has sufficient conductivity due to the dentin tubules it contains, the change in electrical conductivity can be easily measured if demineralization reaches the enamel dentin junction.[49,50].

Pincus, mentioned the Electronic Caries Monitor, claiming that any pit or fissure caries can be diagnosed due to an increase in its electrical conduction. The use of the method is based on the difference in conductivity between healthy tissues and decayed or demineralized tissues. In this method, intact enamel surfaces of inorganic matter content, due to lack of oral fluid or demineralized enamel surface conductive spoiled little or no permeability increase or against demineralization of the tooth area on the porous formed as a result of the expiration on these surfaces as a result of the formation of no is based on measurable electrical conductivity.[51,52]

One of the important advantages of ECM is that it provides objective results regarding the progression, arrest or remineralization of the carious lesion.[53] The disadvantage is that it is time consuming to use in routine whole mouth examinations.[54] In addition, it can be said that the ECM does not distinguish hypoplasia, hypocalcification, and coloration, reports false results in short circuit conditions during measurement, and does not provide any evidence of inactive or active caries.[55] At the same time, false results can be obtained in cases of staining in the examined area of the tooth and as a result of improper contact between the probe of the device and the tooth surface.[56]

Electrical Impedance Spectroscopy (EES, EIS) is another device that works based on electrical conductivity difference. It is an instrument that scans electrical frequency distributions and gathers information on capacitance and impedance among other parameters. Unlike ECM, it collects data using different frequencies instead of a fixed frequency.[57] Alternating Current Impedance Spectroscopy (AAIS) is one of the non-invasive methods developed for caries detection with technological developments. The alternating current impedance spectroscopy method is based on the direct application of a low voltage current to the tooth surface and the evaluation of the change in mineral density in the tooth tissue by this current.[58] This method involves passing a non-sensitizing alternating electric current through the tooth to detect the presence and area of caries. While healthy dental hard tissues have high resistance and impedance, this rate decreases in the case of demineralization.[59]

According to Katge et al., reported that the latest device of the technique, CarieScan Pro, can be used to detect occlusal caries of primary molars in their in vivo study. In the study where the diagnosis of occlusal caries of primary teeth was compared with a visual inspection, bitewing radiography, and Cariescan Pro, it was reported that the sensitivity and specificity of Cariescan Pro were high.[60]

5. Ultrasonic Imaging System

It is a non-invasive imaging method that is preferred by patients and physicians in soft tissue analysis that does not contain ionizing radiation such as X-rays and has very few side effects. The basic principle of ultrasound is based on the application of high-frequency waves generated by the probe (with a frequency that the human ear cannot detect (20,000 Hz and above)) to the material or biological tissue to be tested, the returning waves are absorbed by the probe and converted into electrical impulses with the help of computer software.[61,62] The transducer in the probe or scanner converts the electrical impulses into ultra-high frequency sound waves and transmits them to the tissue. The probe processes the reflected sound waves by converting them to electrical impulses and sending them to the monitor.[61,62] When ultrasonic waves encounter a different environment, their behavior changes, with this feature it is possible to distinguish between solid and demineralized enamel.[63] Compared to periapical radiography, which is frequently used in the clinic as a caries diagnosis method, the ultrasonic system has been found to give significantly higher sensitivity but lower specificity values, but not using ionizing radiation has been reported as an advantage.[64]

6. Fluorescent Techniques (Laser Fluorescence Method)

Early detection of dental caries and the application of preventive applications and minimally invasive treatments are essential elements of modern dentistry.[65] Laser fluorescence (LF) is a device used in the methods used for the diagnosis of caries in dentistry. The fact that the diffusion coefficient of light in carious tissue is higher than in healthy tissue is the basis of laser fluorescence. Dental hard tissues have autofluorescence, which is defined as a characteristic type of fluorescence. A light that will create fluorescence is applied to the tooth tissue, and as a result, the presence of caries is detected by a non-invasive method by measuring the fluorescence difference between healthy and carious enamel.[66] More intense fluorescence was found in carious tissue compared to intact tissue.[67]

In light of the knowledge about fluorescence, the DIAGNOdent device, which is based on laser fluorescence, was introduced in 1998 for the detection of caries lesions. DIAGNOdent is a device used in the diagnosis of caries by using laser light. It consists of a probe, fiber optic cable, laser diode, and electronic unit. There is a control and instrument panel on the electronic unit. The digital panel shows both the actual value in the area where the measurement is made and the highest value measured on that point.[68] It is reported that the DIAGNOdent device is especially successful in the diagnosis of initial caries and hidden caries. As a result of many studies evaluating the effectiveness of the device, the DIAGNOdent device has been described as a successful system that assists traditional examination methods in both primary and permanent teeth.[69–72]

The DIAGNOdent device was developed and the "DIAGNOdent Pen" device operating with the same mechanism was produced.[73] According to DIAGNOdent, its important advantages are that it is light, flexible, and practical and that the tips can rotate around their axis.[74] Chen et al. evaluated 256 tooth surfaces in 96 children in their in vivo study and reported that the use of a DIAGNOdent pen can be an alternative for cases where radiographs are difficult to obtain in pediatric patients and can reduce radiographs.[75] However, it has been noted that the very expensive DIAGNOdent pen device can also be a disadvantage. In contrast to this study, Mendes et al., radiography and DIAGNOdent pen were compared in the detection of interface caries, and it was reported that the DIAGNOdent pen did not contribute to visual examination.[76]

The advantages of the system are that it does not contain X-rays, allows early caries detection in fissures that are difficult to diagnose clinically and radiographically, has low laser power and reproducibility, and is a painless method.[67] It has been reported that the device is more sensitive to the volume of the lesion rather than the depth of the lesion and is more successful in identifying advanced caries lesions.[72,77]

7. Camera and Fluorescent Technique Combination

Quantitative Light Fluorescence (QLF) is a technique developed by using light instead of laser in the laser fluorescence method. Thus, it is aimed to eliminate the harmful effects of a lasers by using light.[78] The measurement of caries lesion is provided by using the relationship of mineral loss in tooth decay with the principle of scattering of light. The QLF method is defined as a fluorescence method based on measuring the loss of fluorescence following demineralization in the dental tissue and numerically specifying the changes detected in the fluorescence amounts.[79,80] In the examinations performed with QLF, demineralized enamel tissue appears to be darker than healthy tissue, since tooth enamel has a certain amount of fluorescence, that is, autofluorescence, under a certain wavelength of light, and the fluorescence feature of demineralized enamel tissue is less than that of healthy enamel tissue.[33,81,82]

QLF, which offers various advantages in the diagnosis of dental caries, is recommended to be used carefully in case of discoloration and structural defects on the tooth surface. Since it cannot distinguish between caries, hypoplasia or anatomical features, QLF must be supported by clinical examination and developmental hypocalcified areas must be visually distinguished from caries lesions.[50] Today, fluorescence images and losses of dental tissue obtained with the QLF system are recorded and digitized, and mineral loss in carious lesions can be analyzed quantitatively. In the QLF system, the difference in the size of the lesion can be determined by measuring the change in the mineral content of the lesion at different times by making repeatable measurements as a result of saving the images to the computer.[83] For this reason, it is reported that the QLF system can be used as an effective and sensitive method in the follow-up of lesions after treatment, as well as detecting small mineral changes that occur in the initial stage of demineralization.[84]

Gomez et al., in order to investigate the effectiveness of various diagnostic methods such as QLF, ICDAS, FOTI, and OCT in the early diagnosis of occlusal caries, compared the findings obtained regarding the lesion depths of occlusal caries in 120 extracted teeth concerning histological sections, and found that all methods were effective in the diagnosis of occlusal caries. have similar performance; It has been reported that ICDAS, which is a visual method, is sufficient for the detection and evaluation of lesion depth in clinical practice, and other advanced diagnostic technologies can be used as an auxiliary diagnostic method.[85]

Today, QLF technology can be used as a reliable method in the diagnosis of early carious lesions and the follow-up of applied treatment approaches; however, it was stated that it should be evaluated together with traditional methods, especially in teeth with structural defects and discoloration.

8. Developing Methods

In addition to modern caries diagnosis methods, there are new techniques that are under development and research continues.

8.1. Canary System (Photothermal Radiometry and Modulated Luminescence Technique):

Canary is a laser-based system used to visualize the crystal structure of the tooth and dental caries by using heat and light together.[86] In the field of dentistry, photothermal radiometry and modulated luminescence (PTR-LUM) technique use energy conversion technology to examine and image dental tissues. In this method, laser light pulses directed to the tooth and heat emitted from the tooth surface in response to these modulated pulses (photothermal radiometry or PTR) and light (luminescence or LUM) are evaluated together.[2] With the simultaneous measurement of reflected heat and light, information can be provided about the presence and size of caries under the tooth surface, as well as the presence of caries can be detected earlier than it is determined by dental radiographs. It has been reported that early detection of carious cavities with Canary can reduce the need for more expensive and invasive treatments to teeth.[59]

8.2. Terahertz imaging:

Terahertz technology is one of the most studied research topics recently, attracting attention with its sensing, imaging, and high-speed data transmission capability. It has been determined that terahertz waves are highly absorbed by water, are not ionizing like X-rays and ultraviolet light, and are harmless.[87] Karagöz et al. studied the sensitivity of the imaging system by examining the structural changes due to mineral content changes in tooth samples sectioned with the THz imaging system they used in projection mode. The results obtained were compared with X-ray radiography.[88] As a result of the study, the contrast difference between healthy and decayed tooth tissue could be successfully demonstrated for the studied frequency ranges. The findings obtained are in parallel with the x-ray images. In particular, imaging in the frequency range of 0.4 THz allows the visualization of different variations between healthy and carious tooth tissue. In line with the results obtained, it was concluded that the THz imaging system is a successful method in examining dental caries. It has been reported that future studies will focus on the relationship between the frequency range and tooth composition.

8.3. Multiphoton Imaging Microscope:

Multiphoton imaging microscope; It has been used in dentistry research, in the diagnosis of caries, and in examining the structural changes in the tooth enamel.[89] Enamel and dentin autofluorescence properties show similar spectral properties and are difficult to distinguish spectrally.[90] These tissues can be distinguished by fluorescence lifetime measurement, and fluorescence lifetime measurement is a method used in multiphoton microscopes. It has been shown that the fluorescence lifetime measurement has the ability to distinguish carious tooth tissue from healthy tooth tissue. However, when single-photon excitation at the wavelength in the visible region is used, initial caries usually starting below the tooth surface is difficult to detect, as it is difficult to penetrate tooth tissue, and multiphoton (two-photon) stimulation has been shown to be more effective in imaging, as it has the advantages of deeper penetration.[91]

The definition of dental caries is the loss of material resulting from demineralization and deterioration of the structure of the organic matrix. Lin et al. used micro-computed tomography (micro-CT) and multiphoton microscopy to measure the mineral density of the samples to assess the mineral loss in caries. In his studies, he evaluated the demineralization of sample dental tissues by fluorescence lifetime measurement using multiphoton microscopy and by micro-CT.[91] They reported that the results obtained by both methods supported each other. These findings may provide an important basis for the use of multiphoton microscopy in the clinical diagnosis of dental caries in the future.

8.4. Fluorescence Spectroscopy:

With the inadequacy of traditional caries diagnosis methods, non-invasive optical methods have gained importance. Many diagnostic methods have been developed based on tooth tissue and its interaction with light. The development of new techniques such as fluorescence spectroscopy has opened up the possibility of detecting superficial lesions such as white lesions.[92,93]

Zezel et al., aimed to determine the characteristics of non-cavitational caries lesions by fluorescence spectroscopy using 405nm diode laser and to compare the fluorescence intensity obtained from the outer surfaces of the samples with those emanating from the center of the lesion and intact enamel.[93]

8.5. Soprolife / Soprocare / Soproimaging:

The Soprolife camera (Acteon, France) is an intraoral camera with 450 nm wavelength emission and 20 nm bandwidth, which illuminates tooth surfaces using two types of LEDs.[86] By combining the autofluorescent image and the anatomical image, Soprolife can detect the differences in the density, structure, and/or chemical composition of biological tissues. It achieves this by providing continuous illumination in one frequency band and fluorescence in another frequency band. The camera is connected to an image sensor (0.25 inch CCD sensor) containing mosaic pixels surrounded by color complementary filters. The image of the tooth is formed as a result of combining the data collected based on the energy reaching each pixel. While four white light LEDs are used for daylight mode of the camera, which has 3 different application modes; In diagnostic and treatment modes, light is provided by four blue LEDs (450 nm).[59] Bruised tissue that appears brown in daylight, dark red with Soprolife; intact dentin is observed as green. Although the enamel tissue does not have a fluorescent color, a bluish color can be observed in the enamel as a result of the diffusion of green light emitted from the dentin.[94]

A new camera, Soprocare, includes 3 different clinical applications as daylight, caries, and periodontal. While the caries mode focuses on enamel and dentin caries, the periodontal mode works to detect periodontal inflammation.[59] Sapro imaging software is a program that saves the captured pictures and provides the opportunity to compare them later. The images created after selecting the magnification and mode (daylight or fluorescent) by positioning the camera on the tooth can be saved by the software.[59]

8.6. Raman Spectroscopy:

Raman spectroscopy is a light-based method based on the scattering of photons by interacting with the molecular bonds of materials. Raman spectroscopy provides data on the molecular structure of the lesion. As a result of illuminating a material with monochromatic light of irregular wavelength, some of the photons in the light undergo a frequency shift and scatter depending on whether the molecular bonds forming that material are in the vibrational or rotational phase. This principle forms the basis of Raman spectroscopy. Raman spectroscopy, which provides information at the molecular level of the sample examined in vitro/in vivo, is seen as a method that can be used especially in biomedical applications.[95]

Recent studies on Raman spectroscopy have shown promising results in the diagnosis of early dental caries.[96–101] Ko et al., studied decayed teeth at the initial stage using polarized raman spectroscopy and showed white lesions and areas of demineralization that were not diagnosed by conventional methods; As a result of their studies, it showed 97% sensitivity and 100% specificity in detecting early caries lesions.[99]

8.7. Confocal Laser Scanning Microscope:

Laser scanning microscopes scan the target to be imaged sequentially, point by point and combine the obtained pixel values with the help of a computer to form the desired image. Thanks to its working principle, laser scanning confocal microscope, a type of laser scanning microscopes, not only provides high resolution images in live organism imaging but also can display tissues up to 1 mm thick in three dimensions by creating vertical sections in the targeted tissue.[102] With the illumination obtained from a focused laser source, the sample is scanned in lines. Reflections coming from outside the focused area are blocked and only the focused area is monitored. The porosities in the demineralized enamel layer are measured by infiltration of fluorescent dyes. Unlike SEM, it makes it possible to examine wet samples and to evaluate them before treatment, although it is not practically applied.[103] Askar et al., used laser scanning confocal microscopy to examine tooth sections in an in vitro study in which they evaluated the penetration depths of resin infiltration-based material and micro-filled resin infiltration-based material.[104]

Conclusion

With the development of technology, many new methods are being developed to ensure the early diagnosis of dental caries. Caries diagnosis methods aim to prevent cavitation in teeth by detecting caries in the early stages or to determining the actual size and localization of existing caries cavities. It is important to develop and use reliable, high-accuracy, and quantitative methods for early diagnosis and follow-up of caries lesions and to make the right treatment decisions. New methods developed for the early diagnosis of caries lesions increase the frequency of diagnosis of lesions that can be healed by remineralization. Especially in pediatric patients, with early detection of caries, treatment procedures can be performed with uncomplicated methods. In primary teeth with less enamel thickness and mineral density, caries reaches deep tissues in a shorter time compared to permanent teeth. This situation increases the importance of detecting caries in primary teeth in the early period. An integral component of both traditional and current decayed diagnosis methods is the dentist who is equipped with clinical experience and knowledge and can use traditional and current methods that are open to follow innovations together.

Author Contributions

E.A and N.Ö conceived the ideas; E.A collected and analysed the data; E.A and N.Ö led the writing.

Conflict of Interest

The authors declare that there have no conflict of interest.

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