ORIGINAL RESEARCH PAPER
Volume - 9 | Issue - 12 | December - 2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

DENTAL CARIES DETECTION: NOVEL APPROACHES

Dental Science

Charan Teja Bobba* BDS, GSL Dental College and Hospital , Andhra Pradesh, India. *Corresponding Author

Shanta Chopra BDS, MDS Deptt. Of Prosthodontics Crown and Bridge & Oral Implantology.

ABSTRACT

Caries detection followed by its treatment had been an integral part of dentistry. Beside periodontal diseases, caries are also a chronic disease for tooth loose. Caries are defined as a multifactorial microbial infectious disease characterized by demineralization of inorganic and destruction of organic structure of the tooth. Conventional examination involve visual inspection, tactile sensation , and radiographs. However these methods are inadequate for the detection of initial lesions. They are helpful only when lesions are cavitated. So these disadvantages leads to various novel methods for detection of caries. The aim of this article is to briefly review the various novel methods of caries detection.

KEYWORDS

Dental Caries, Digital Imaging, Light Emitting Diode

Caries detection followed by its treatment had been an integral part of dentistry. Beside periodontal diseases, caries are also a chronic disease which causes tooth loose. Caries are defined as a multifactorial microbial infectious disease characterized by demineralization of inorganic and destruction of organic structure of the tooth. It is complex and dynamic process as it involves multiple factors that influence as well as initiate the progress of disease[1]. Diagnosis is derived from Greek word dia which means "through" and gnosis which means "knowledge". Diagnosis can sometimes be a complicated procedure as it involve more than just detecting lesions.

The most important factors involved in caries activity are the clinical appearance of a lesion and patient factors such as salivary flow, sugar intake and oral hygiene (Lagerlof and Oliveby, 1996). Thus, caries activity can be evaluated on the basis of data obtained from clinical examination. Early detection reduces chances of irreversible pulpitis, treatment costs and the time needed for treatment and structure of the teeth[2].

Detection of caries has been classified into two methods i.e conventional and novel methods. Conventional examination involve visual inspection, tactile sensation and radiographs. However these methods are inadequate for the detection of initial lesions.They are helpful only when lesions are cavitated. So these disadvantages leads to various novel methods. In the following section of the article some novel approaches for caries detection have been discussed.

1. Digital Imaging

Digital image is an image composed by are orderly distributed series of sensors and pixels. In conventional radiographs about 40% of demineralization is required to detect a lesion. Digital radiography system is based on the principle of image manipulation. It consists of a set of cells that are arranged in rows and columns. Each cell is further classified into three numbers: the x-coordinate, they-coordinate and the gray value. The gray value is a number that corresponds with the X ray intensity at that location during the exposure of the digital sensor. Individual cells are called “picture elements”, which are known as “pixels”.

In an in vitro study conducted by Castro et al comparing the capacity of conventional radiographic with digital imaging systems in detection of proximal caries, states that both these systems provided similar results, showing no significant difference over another. But the advantage of using digital radiographic imaging over conventional is significantly lower radiation dose[3].

The advantages of digital imaging over conventional radiography are as follows

- The radiation dose is approximately 60-90% lower,
- The image receptor is often larger
- The image is immediately available
- The image can be electronically transferred

2. Light-emitting devices

- These devices are supported on the principal of optical properties from sound and carious lesions. Both enamel and dentine show auto fluorescence. Fluorescence is defined as a phenomenon where the light is absorbed in a specific wavelength and then emitted in a higher wavelength.

3. Laser fluorescence devices (DIAGNOdent and DIAGNOdent pen)

It is a non invasive method which was introduced in1998.

Principle: It is predicted on the quantification of light (visible component) from organic components of dental tissues when light of 655nm laser diode (aluminum, gallium, indium and phosphorus - AlGaInP) are emitted located on the red range from the visible spectrum. The tooth is irradiated with light of wavelength 700-15000 nm. Barrier filters are used to measure the resulting fluorescence. With the help of flexible tip light is emitted to dental tissue. Light will be deflected and dispersed from the affected enamel. Fluorophores derived from the products of the bacterial metabolism help in detection of caries.

4. Infrared Thermography

Thermal energy travels in the form of waves. It can measure the changes in thermal energy when evaporation fluid is lost from a lesion. Hence, by comparing the thermal energy emitted by sound tooth structure with that emitted by carious tooth structure detection can be carried out. This methodology involves various sensors usually made up of idium which can detect temperature changes even within the order of 0.025°C.

Precautions:

Distance not more than 20 cm between source-to-sensor and it usually takes time up to 2 min.

Disadvantage: not useful intra-orally as variations in the temperature occur in mouth with respiration or fluid evaporation from other oral surfaces. Moreover difficult to maintain adequate distance between source-to-specimen distance in posterior teeth.[4]

5. Polarized Micro-Raman Confocal Spectroscopy:

It involves examination of various lesions with the help of vibration caused by PO4-3. Caries detection involve vibration as caries shows vibration of increased intensities than sound tooth structure. These PO4-3 vibrations arising from hydroxyapatite crystals in enamel that contribute to the inorganic structure. Theses changes are actually responsible to detect demineralization that causes alterations in enamel crystallite. This hypothesis is supported by reduced Raman polarization anisotropy derived from polarized Raman spectra of carious lesions as polarized Raman spectroscopy was used to study the orientation of enamel rods in tooth. Carious surfaces under polarized microscopy, appears like light yellow region deep in the enamel.

Disadvantages: Difficult to observe carious lesion at enamel-dentin interface.[5]

6. Optical Coherence Tomography (OCT)
OCT is an imaging technology that provide high-resolution images with depth of around (10–30μm) .

Principal: Uses sound waves in detecting lesions i.e coherent backs scattered light.

Hence provides image resolution that is an order of higher magnitude. Thus, OCT is better suited for imaging near surface structures. OCT system contains a interferometer known as Michelson that splits a beam of light into 2 paths, bouncing the beams off 2 mirrors (1 fixed, 1 moving) then recombining the beams. This interference pattern generates a depth profile at a single point along the laser trajectory. This point is known as an A-scan. As the laser is moved across the surface laterally, adjacent A-scans are assembled to produce an another 2-dimensional–scan known as a B scan[6].

7. Multimodal Imaging System:
This method has been very useful in detecting caries lesion with high sensitivity, however it is used in combination with other technique such as reflectance, fluorescence, and OCT imaging. fluorescence provide information about biochemical composition .OCT provide information about tooth structural information whereas reflectance give information about imaging, calculus, stain, and amalgam. Thus,using this technique with combination enable higher sensitivity . It involve use of a polarizer to illuminates the tooth surface.

Mechanism:

Use of polarization beam splitter (PBS)

↓

light reflects and scatters back from the tooth

↓

PBS act as an analyser to block the light of same polarization but transmits the light to the sensor.

↓

blockage of blue excitation light, a long pass filter (LP) is placed in sensor.

↓

block the blue excitation light while transmitting visible light, hence system capture visible images .

Use of OCT imaging system involve use of dichroic mirror is used to direct the light from the OCT subsystem to the tooth surface. Another advantage of using this technique is it provide multiple images that helps in better detection at various angles. OCT imaging after locating carious and suspicious regions provide more detailed information, such as decay depth, size, and boundary around lesions. All three images produced by reflectance, fluorescence, and OCT, can be saved for further monitoring[7].

8. LED technology
Device involves a light emitting diode (LED) range between 635 nm and 880 nm and detect reflectance and refraction of the emitted light from the tooth surface. Emitted light are captured by fiber optics and are then converted to electrical signals for detection. The microprocessor of the device identifies different optical signature for both healthy and demineralized tooth. The demineralization tooth structure leads to a change in the LED color from green to red along with a simultaneous audible signal, which is directly related to the severity of caries lesions. The faster the signal, deeper is the lesion.

FIGURE 1: LED technology

9. Fluorescence camera (VistaProof) :
It involve use of intraoral camera Vista Proof which consist of six blue LEDs emitting light of 405-nm. This camera helps to digitize the video signal from the dental surface with fluorescence emission using a charge coupled device. It is possible to see different areas of the dental surface that fluoresce in green (sound dental tissue) and in red (carious dental tissue)[9].

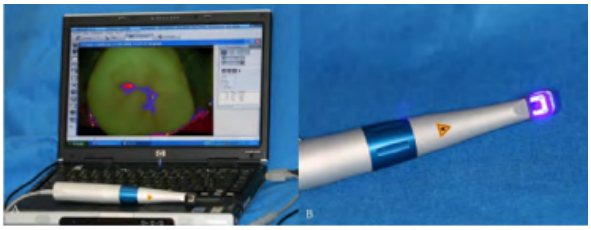

FIGURE 2: Fluorescence camera

REFERENCES

1. Sivapathasundharam, B., 2020. Shafer's Textbook of Oral Pathology E-book. Elsevier Health Sciences.
2. Ingle, J.I., Bakland, L.K. and Baumgartner, J.C., 2008. Ingle's endodontics/John I. Ingle, Leif K. Bakland, J. Craig Baumgartner. Hamilton, Ont.: BC Decker.
3. Castro, V.M., Katz, J.O., Hardman, P.K., Glaros, A.G. and Spencer, P., 2007. In vitro comparison of conventional film and direct digital imaging in the detection of approximal caries. Dentomaxillofacial radiology, 36(3), pp.138-142.
4. Hall, A. and Girkin, J.M., 2004. A review of potential new diagnostic modalities for caries lesions. Journal of dental research, 83(1_suppl), pp.89-94.
5. Ionita, I., 2009. Diagnosis of tooth decay using polarized micro-Raman confocal spectroscopy. Rom. Rep. Phys, 61, pp.567-574.
6. Almahdy, A., Downey, F.C., Sauro, S., Cook, R.J., Sherriff, M., Richards, D., Watson, T.F., Banerjee, A. and Festy, F., 2012. Microbiochemical analysis of carious dentine using Raman and fluorescence spectroscopy. Caries Research, 46(5), pp.432-440.
7. Liang, R., Wong, V., Marcus, M., Burns, P. and McLaughlin, P., 2007, February. Multimodal imaging system for dental caries detection. In Lasers in Dentistry XIII (Vol. 6425, p. 642502). International Society for Optics and Photonics.
8. Rodrigues, J., Hug, I., Neuhaus, K.W. and Lussi, A., 2011. Light-emitting diode and laser fluorescence-based devices in detecting occlusal caries. Journal of biomedical optics, 16(10), p.107003.
9. D.P.; Braga, M.M.; Rodrigues, J.A.; Freitas, P.M.; Imparato, J.C. & Mendes, F.M. (2010). Reliability and discriminatory power of methods for dental plaque quantification. Journal of Applied Oral Science, Vol.18, No.2, (March-April), pp. 186-193, ISSN 1678-7757.