

DIAGNOdent LASER DEVICE: A REVOLUTION IN CARIES DETECTION

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**ABSTRACT:** The diagnosis of dental caries is fundamental to the practice of dentistry. The accuracy of diagnosing "hidden" occlusal caries is recognized to be a challenge. These lesions are virtually impossible to detect using conventional methods. DIAGNOdent is a laser fluorescence device used for detecting caries. The main attraction of such a device is that it is able to identify signs of tooth decay earlier than traditional diagnostic methods. It utilizes laser light of a defined wavelength to help detect and quantify demineralized tooth substances without x-ray exposure. This revolutionary new device is easy to use and turns caries detection into a harmless, measurable, more reproducible and exacting procedure.

**KEYWORDS:** Laser fluorescence, Caries detection, Diagnosis

INTRODUCTION

DIAGNOdent is a small laser instrument which scans teeth with harmless laser light searching for hidden decay. DIAGNOdent is an extremely accurate and reliable adjunct for the detection of sub-surface caries. DIAGNOdent extends the dentist's vision into those hard-to-reach and hard-to-see sites where caries can develop, multiply and thrive. Left undetected, sub-surface caries can cause major damage to a tooth's structure, resulting in extensive restorative work or even tooth loss. This new technology is completely safe and pain free. This unique instrument provides instant feedback on the health of the tooth. A pen like probe simply glides over tooth surface constantly checking the health of the tooth (Fig.1 and Fig 2). A number scale and an alarm signal the operator when there are signs of hidden decay. It is generally not possible to probe drop-shaped fissures. The DIAGNOdent's leading technology helps differentiate healthy from diseased tooth structure without resorting to guesswork. Scanning teeth with DIAGNOdent allows dentists to detect caries as early as possible, improving treatment options and providing patients with optimal oral health care.



Fig.1. DIAGNOdent laser device

HOW DIAGNOdent WORKS?

DIAGNOdent: THE NEAR INFRA RED FLOURE-SCENCE METHOD :

DIAGNOdent has the great advantage of detecting caries in the very early stage by measuring the laser fluorescence within the tooth structure. Fluorescence is a phenomenon where light at one wavelength (excitation wavelength) is absorbed by the tissue and emitted at second longer wavelength (emission wave length). Enamel and dentin have a certain natural fluorescence that is called as auto fluorescence. This is attributed to some chromophores present in the dental structure. Red light, as well as infrared fluorescence radiation is less absorbed and scattered by enamel than light of shorter wavelengths, so that it penetrates the tooth more deeply. It is therefore possible to measure fluorescence from underlying carious dentin. Carious lesions as well as the biofilm fluoresce on incident light. This is attributed to protoporphyrin, which is a bacterial break-down product. It is found that red light induced fluorescence could differentiate between sound and carious tooth tissue. The difference in the fluorescing capacity of the sound tooth and the carious lesion can be recorded or observed.

TECHNOLOGY

DIAGNOdent, a laser fluorescence-based instrument was introduced in 1998 as a complement to conventional methods for the detection and quantification of carious lesions. The DIAGNOdent device consists of a main control unit and a hand-held probe.(figure 1).The main control unit is connected to a hand probe by a cable, with descendant and ascendant optical glass fibers. The probe comes with 2 attachments, one intended for occlusal surfaces, and the other with the flat tip for smooth

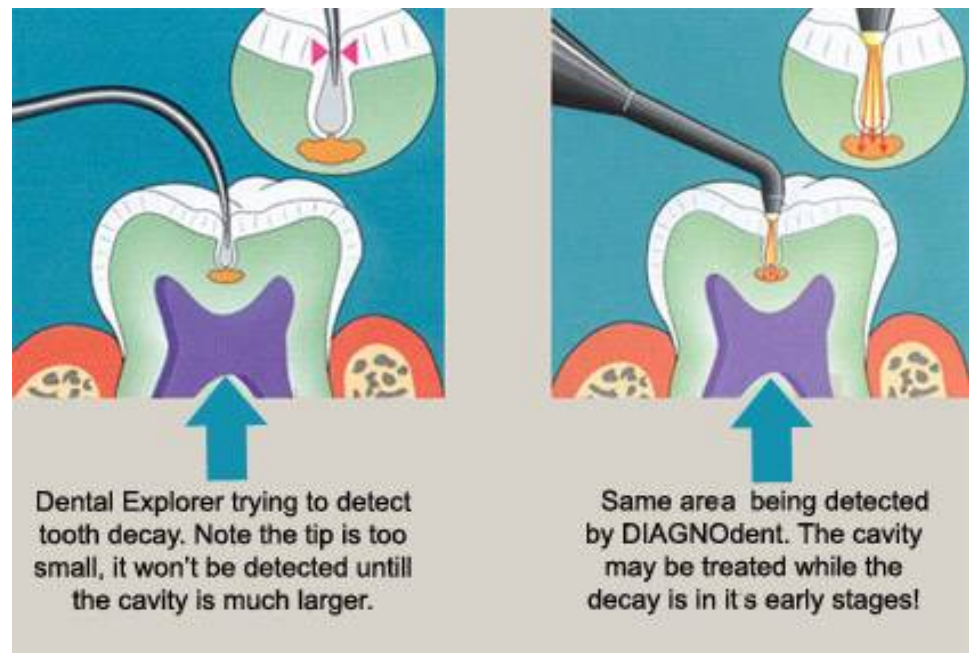


Fig.2.Difference between DIAGNOdent and probe

surfaces. The main DIAGNOdent unit contains a laser diode (655nm, modulated, 1 mW peak power) as the excitation light source, and a photo diode combined with a band pass filter (transmission >680 nm) as the detector.

Laser light is generated by the main unit and transmitted through the excitation optical fiber to the tip of the hand piece. Once the tip is in contact with a tooth surface, the laser energy penetrates the tooth surface and is absorbed by the surrounding tooth material, and fluorescence within the infra-red spectrum occurs. The emitted fluorescence, as well as backscattered ambient light, is collected by the tip and carried back to a photo diode detector in the main unit via the detection fibers. The band pass filter absorbs the backscattered excitation and other short wavelength ambient light and transmits the long-wavelength fluorescence radiation. To eliminate the long-wavelength ambient light also passing through the filter, the laser diode is modulated, and only light showing the same modulation characteristic is registered by the main unit and displayed as nominal values ranging from 0 to 99, where 0 indicates minimum and 99 maximum fluorescence (**Fig.3**). However, decayed tooth structure will exhibit fluorescence, proportionate to the degree of lost tooth structure, resulting in elevated scale readings on the display of the DIAGNOdent. An audio signal allows the operator to hear changes in the scale values, enabling focus on the patient and not solely on the device. This is beneficial not only for detection of decay, but also for patient acceptance of treatment plans. The underlying mechanism is that carious tissue emits stronger fluorescence than sound tissue in the red and infrared part

of the spectrum ( $\lambda = 655 \text{ nm}$ ). Thus, the fluorescence from a carious region, greater than that from sound tissue, is expressed as a higher numerical readout by the device.

Stages of dental decay with DIAGNOdent

Stage 1:

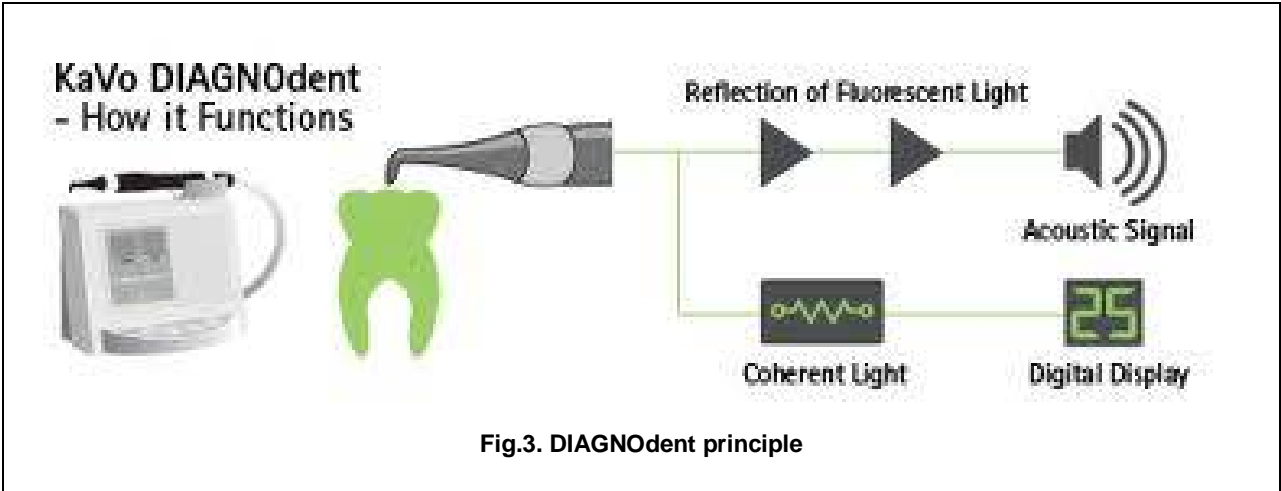
DIAGNOdent value: 0-14 described as no caries or histological enamel caries. Acid attacks the tooth surface. This process gradually dissolves the hard outer coating of the tooth (enamel) causing a lesion. Require no active care or treatment

Stage 2:

DIAGNOdent value: 15 - 20 histological enamel caries extending beyond the outer half, but confined to the enamel. Frequent acid attacks to the enamel surface will allow the decay to travel deeper into the enamel. Require preventative care, depending on the patient's caries risk.

Stage 3:

DIAGNOdent value: 21 – 99, histological dentinal caries. If frequent sugar consumption continues the decay process will penetrate the hard enamel and enter the softer 2<sup>nd</sup> layer (dentine). If the decay is left to progress it destroys the softer dentine layer even more. Require operative and preventative care.



**Benefits of the DIAGNOdent Laser Cavity Detection System**

**Accurate and safe method of caries diagnosis:** Over 90% accurate in detecting lesions not detectable with an explorer or bitewing x-rays. Early, initial caries and hidden caries may be safely detected using the LASER fluorescence technology of the DIAGNOdent.

**Reliable detection of fissure caries:** Generally, conventional hand instruments may not be used to probe within drop-shaped fissures. The DIAGNOdent offers the advantage of measuring fluorescence deep within the fissure pattern, as LASER light is easily penetrates the enamel and is reflected by even the smallest lesion. (Fig.4).

**Conservative:** Prevents exploratory excavation or under-treatment of suspect teeth. Early detection of pathological changes that are undiagnosed by conventional examination methods (e.g. initial lesions, demineralization and changes in the enamel, fissure caries). Therefore, preservation and protection of healthy tooth tissue.

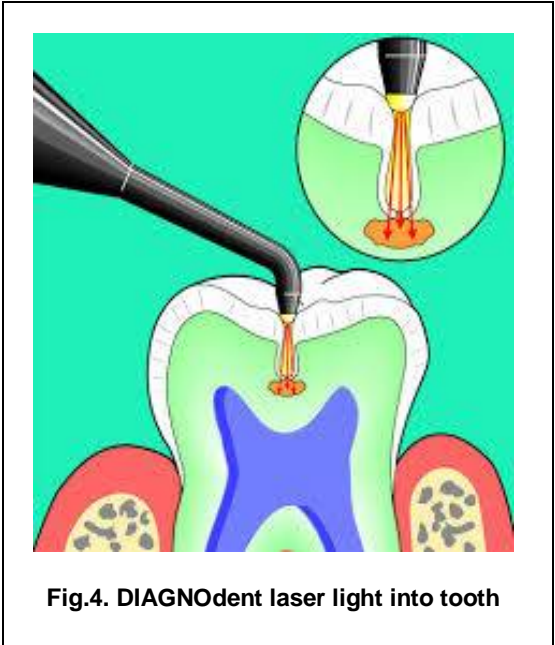
**Quantifiable:** Precise, reliable measurement allows objective monitoring of caries activity overtime. Reproducible results permit checking, stabilization and documentation of caries

**Safe:** Uses light energy, and no x-ray exposure. Increases patient confidence about treatment decisions due to accurate visual and acoustic representation of measured values.

**Limitations of DIAGNOdent**

- DIAGNOdent has a tendency to provide false positive diagnoses in the presence of stains, biofilm, and fillings, to get consistent readings it is essential to test on a clean tooth.
- Limited accessibility to the embrasure prevents accurate reading of interproximal surfaces.

- Composite resins can fluoresce, prompting elevated readings; hence the DIAGNOdent should not be used on these materials.
- Caries underneath amalgam restorations is measured accurately only if there is caries at the margin, however if the caries is under the floor of the amalgam the reading will not be accurate.
- DIAGNOdent cannot be used always to determine caries if excavation is complete especially in some conservative preparation designs, particularly those with small access openings, limit proper tip angulations within a preparation.
- If used in deep preparations, in close proximity to the pulp; elevated values may be obtained, possibly resulting from fluorescence of underlying pulp and not necessarily as a result of caries. Therefore, the use of other diagnostic methods to determine extent of affected tooth structure should be employed in these situations.



**CONCLUSION**

The laser device DIAGNOdent can be used as a valuable and preventive diagnostic tool as an adjunct to visual examination. Caries diagnosis of DIAGNOdent exhibited a higher reproducibility in detecting occlusal caries and a higher validity than conventional methods. Currently, visual examination and conventional radiography are widely used in the identification of caries. However, limitation in identifying early demineralization or hypo mineralization exists because they are qualitative and subject to operator interpretation. DIAGNOdent provides a sensitive and quantitative measurement for decreased mineral content. Early detection is the most ethical way of treating disease. With DIAGNOdent's diagnostic capabilities, caries can be accurately identified, monitored and/or treated earlier than ever before.

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