The new DiagnoDENT pen represents the most significant advance in fluorescence diagnostic tools for clinical practice since the original DiagnoDENT was released in Australia in 1999. The new unit uses the same optical principle of fluorescence and has identical performance (in terms of readings). Its small size is due to a different display (liquid crystal display rather than light emitting diodes) which makes the unit smaller and gives it a longer battery life (requiring only 2 AA batteries rather than 5). Having a hand held unit is very convenient, and there is little learning curve adapting from the older style unit to the new “pen” configuration. As with the earlier models, the DiagnoDENT pen gives a variable pitch acoustic signal and records both the more important “peak” score (in large digits) as well as the momentary score (in small digits).

How it works
The DiagnoDENT device is based on principles of detecting bacteria by using low power pulsed visible red (655nm wavelength) light to elicit infrared (i.e. invisible, 650 to 850 nm wavelength) fluorescence. Bacteria emit this because they contain porphyrin molecules, which are electronically excited by the incoming red light. This photochemical effects occurs regardless of whether the bacteria are in a plaque biofilm, within infected carious dentine, or trapped within subgingival calculus. This means that the device has a wider range of applications, including the detection of occlusal caries, proximal caries, subgingival calculus, and subgingival plaque, and to that end different tips have been designed to meet the optical requirements for each application. All the tips in the new DiagnoDENT pen are a single piece of sapphire crafted to the optimal shape to transmit and collect light. This point is the major reason the “pen” version has attracted wide interest - the development of simpler sapphire probes which extend the capabilities of fluorescence diagnosis to proximal caries (is it cavitated?) and subgingival calculus (how good was that debridement?).

For fissure caries diagnosis, it is well known that conventional means for detecting caries on fissured surfaces of teeth (such as visual examination, probing and X-rays) have limitations and can easily overlook small lesions. The fluorescence diagnosis method has a very high specificity (with almost no false positive responses), with a good sensitivity (ability to detect true positive lesions). Both sensitivity and specificity with laser fluorescence are substantially better than current clinical techniques, as has been shown in clinical studies and in laboratory studies using extracted teeth, in which the teeth are finally sectioned to determine the presence and extent of caries histologically (the gold standard). Clinical studies have confirmed the high sensitivity and specificity of the DiagnoDENT for caries in both permanent and deciduous teeth.

For assessing fissures, the original DiagnoDENT uses a tip comprising a central emitter fiber and a ring of collector fibers. In the DiagnoDENT pen, the occlusal sapphire tip is shaped like a truncated cone, and gives exactly the same optical performance as the previous fissure “A” tip that many practitioners will already be familiar with, in their search for hidden lesions in pits and fissures.

The proximal caries tip has a bevel which directs and collects the light at 100 degrees - this makes it work like a right-angled periscope, so that applying it into a proximal space allows the proximal surface of one posterior tooth to be assessed. It is essential that plaque be removed from
between the teeth first, since this may give a (false) positive signal. The periscope is marked so it is simple to tell which direction it is facing (mesial or distal). The presence of plaque in a cavitation and the underlying bacterial infection of the dentine give a strong reading and give the clinician an answer to that important question – is this surface cavitated?

Using the new DiagnoDENT pen can assist the practitioner in moving to a minimally invasive approach to caries management. Detection of caries at a very early stage may permit more efficient arrest and reversal of the caries process than when lesions are detected at a more advanced stage. For example, regular flossing coupled with the use of casein phosphopeptides (GC Tooth Mousse) and low concentrations of fluoride can arrest and reverse “white spot” lesions on smooth surfaces. Such early intervention will reduce the need for irreversible restorative procedures. Because laser fluorescence employs low power non-ionizing radiation, it can be used with safety at every appointment to assess and monitor lesions. It is quantitative and reliable. Most importantly, unlike dental X-rays, there are no concerns with its repeated use in the longer term. Because of the imprecision of current means of caries diagnosis clinically, and the likelihood of missing small fissure or approximal lesions in bitewing radiographs, the DiagnoDENT method is without doubt an important adjunct to the modern dental practice. It should be used together with a proper caries risk assessment, which takes into account evidence of past or current caries, and the various lifestyle and medical factors which can alter caries risk.

**Calculation detection**

An exciting new use for laser fluorescence is calculation detection. Using this same theory as for caries, a healthy root surface can be unambiguously distinguished from a root surface with subgingival calculus and plaque, by applying a light probe into the periodontal pocket. The calculus detection tips exploit the design features of the sapphire tips developed for the KaVo KEY3 laser, which exploits the fluorescence signal for controlling laser debridement of the root surface. While other methods of calculation detection using light or sound energy have been developed in recent years, these give a binary “yes/no” rather than variable (how much) readout to the operator. When visible red laser light is applied to calculus, there is a large separation between the fluorescence intensities between calculus (which fluoresces strongly) and healthy tooth surfaces (which have a reading of 5 or less). Regions with calculus can be distinguished unequivocally with the aid of this simple non-contact method of investigation. It would seem to be an essential tool for dental hygienists and periodontists as it can give an endpoint to the process of debridement.

**DiagnoDENT, model 1**

**Tips for clinical use**

Optical factors can potentially affect the reliability and performance of laser fluorescence, of which the most important are the presence of water or stains on the tooth surface. While other methods of calculus detection usually give a (false) positive signal, the DiagnoDENT may give a false positive fluorescence signal, and this can be checked for easily by testing samples of the materials used in the practice on the bench.

An important issue is selecting the appropriate cut-off levels between sound and carious tooth structure, since this will influence the decision of the operator to intervene restoratively. When considering the reading obtained at an individual site within a tooth, it is important to bear in mind the factors which can affect this reading, and the implications this has in terms of the treatment provided. The risk of overtreatment is dealt with by selecting an appropriate value for non-reversible (tooth cutting) interventions, which takes into account the normal background fluorescence of sound tooth structure (a reading of 5 is obtained from healthy enamel and dentine).

**Emerging areas of use**

An emerging use for the DiagnoDENT approach is to identify residual caries remaining after caries removal. Studies conducted at the University of Queensland using extracted teeth with frank cavitations and stepwise caries removal using a range of methods (excavators, rotary instruments, Carisolv, or Er:YAG lasers) have shown that DiagnoDENT values reduce during caries removal with all methods, from the initial baseline reading, to reach a level of 5 at the cavity floor, and 9 at the DEJ, for each method of caries removal. Reductions in readings during the procedure were comparable to the extent of infected carious dentine removed (as would be expected). Recent research conducted in Dusseldorf has confirmed this by biochemical tests of the dentine for collagen cross-links (which differ between infected and affected carious dentine).

**Further reading**

For the technophiles amongst us, the following United States patents outline the inner workings of the laser fluorescence technology used in the DiagnoDENT: 6,561,802; 5,897,314; 5,971,755; and 6,135,774. These can be accessed via the web at http://www.uspto.gov.

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