Detecting dental caries: Is there anything new?

An overview of the latest technologies and their clinical potential

Dental caries is still one of the most prevalent but preventable diseases in the world. There is increasing evidence that those with poor oral health have poorer general health outcomes as well. Whether this is a causative relationship or an association with other co-factors is yet to be determined.

Even though a large proportion of the population in developed countries have seen improvement in their oral health over the past three or four decades, individuals from certain groups, such as lower socioeconomic groups and the medically compromised, are still at high risk of developing dental caries. There has been a change in the philosophy around what is considered appropriate treatment, with a move away from the surgical model to a disease management model, often termed minimum intervention dentistry.

As a result of the decline in caries experience, the sensitivity of caries diagnosis has been reduced. Early diagnosis is vital, as it allows intervention to remineralise or heal the carious lesion, whilst also addressing the caries risk factors and undertaking preventive actions, such as fissure sealing (Figs. 1a & b).

Dental caries is confusing to many due to the profession using the same term for both the disease process and its outcome. A distinction should be made between these separate but interlinked processes: the diagnosis of dental caries, the detection of a carious lesion, and the assessment of that lesion. While caries diagnosis involves the assessment of the whole individual, considering all caries risk factors, such as personal and social factors, oral environmental factors and daily factors directly contributing to the caries risk of the individual and of the specific tooth surface, caries detection involves the use of an objective instrument to detect the disease in the form of carious lesions, with assessment characterising and quantifying the extent and status of disease.

The development of the International Caries Detection and Assessment System (ICDAS) for the quantification of carious lesions has recently provided a valid method for assessing and quantifying lesions, and the recent addition of an associated management system, the International Caries Classification and Management System (ICCMS), provides evidence-based management options for the various stages of the carious lesion, allowing for individual circumstances. ICDAS rates lesions from a score of 1, the earliest stage where the tooth needs to be dried to identify a white spot lesion, to 6, which represents an advanced lesion. Educational software is available (www.icdas.org) and recently software is to aid in the use of ICDAS in epidemiological surveys has been released (www.icdas.org/software/tools).

Using a probe or explorer as a caries detection method presents in both clinical practice and undergraduate dental education but it may damage the surface layer of demineralised enamel, increasing the likelihood of the need for restorative intervention. Probing provides no advantage over other detection methods, even when interpreted in conjunction with them, so it is recommended that only a ball-ended probe be used, especially to check enamel surface integrity/roughness.

The sensitivity of a detection method relates to its ability to detect the disease when it is present, and the specificity relates to the ability to detect the absence of the disease when it is not present. Occlusal caries detection is complicated clinically by surface morphology, past fluoride exposure, anatomical fissure topography, and the presence of plaque and stains. Commonly used methods for this type are visual and tactile inspection, radiography, transillumination and laser fluorescence. This method, namely DIAGNodent (KaVo), is promoted for use for both occlusal and interproximal lesion detection, with the technology based on the fluorescence of porphyrins excited by laser light at a wavelength of 655 nm (Figs. 2a & b). The sensitivity and specificity of laser fluorescence in detecting intra-dental lesions varies greatly, with false positives, the major limiting factor of the technology. In order to achieve the best results, the angulation of the tip should be consistent, and the results should be seen in conjunction with other detection methods, not as a stand-alone gold standard.
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Recently developed quantitative light-induced fluorescence systems (including QLF, Inspektor Research Systems, and SOPROLIFE, Acteon) utilise differences in auto-fluorescence and SOPROLIFE, Acteon) utilise differences in auto-fluorescence between sound and demineralised enamel and dentine (Fig. 3). Demineralised enamel appears darker than the adjacent sound tooth structure, and the carious dentine fluoresces red depending on the filters used. The use of QLF (wavelength 405 nm) enables the early detection of enamel demineralisation, and it may be used to discriminate between affected and infected dentine. Like DIAGNOdent, QLF technology is reliant on standardised techniques, especially control of ambient light, and the results must be seen in conjunction with other methods. SOPROLIFE uses a longer wavelength of 450 nm, and has settings for the diagnosis of carious dentine, as well as a treatment mode, which assists in determining which dentine should be removed.

A new system recently released uses laser-based photothermal radiometry (The Canary System, Quantum Dental Technologies), detecting luminescence and change in temperature to quantify mineralisation changes (Fig. 4). Further research is required on this technology.

The method of fibre-optic transillumination is based on the principle that sound tooth structure has a higher index of light transmission than a carious tooth. Units such as the SDI diagnostic tip for SHF’s light curing unit or the NSK transillumination handpiece are simple to use. The light source is placed on the buccal or lingual side of the tooth as in Figure 5 illustrating the head of the SDI unit. Transillumination is primarily used for the detection of proximal carious lesions, although studies have indicated it can also improve visual detection of occlusal lesions. Carious lesions limited to the enamel appear as grey shadows, and those in the dentine appear as orange-brown or bluish shadows.

The use of digital radiography has become commonplace among many practitioners. The detection capabilities of digital radiography are reported to be similar to that of film-based methods, and have the benefit of reduced radiation exposure and the ability to readily transfer the images.

The recent development of multilimb disclosing gels (Tri Plaque ID Gel, GC Corporation) may aid caries detection, as old and cariogenic plaque can be identified relatively easily—and white spots tend to occur under older plaque, so this can target the areas to be investigated after gel removal. These products are potentially good for patient education, as the area of risk can be easily pointed out to the patient.

Obtaining diagnostic reproducibility between examiners is difficult, as clinicians tend to develop individual concepts based on experience regarding caries detection and the subsequent preventive or restorative treatment options. Length of experience also contributes, with experienced examiners having higher sensitivity, higher specificity, and greater reproducibility than those less experienced. Owing to the lack of a single detection method that provides both high sensitivity and high specificity, combining a number of methods is recommended to increase the accuracy of detection. For example, this may mean combining DIAGNOdent or SOPROLIFE findings with direct visual and radiographic images. Several factors, such as fluorescent lighting, can upset the results of fluorescent-based detection methods, so care in control of ambient lighting and standardisation of methodology is imperative when using these new detection methods.

The development of new technologies to assist in the detection and diagnosis of caries can provide increased reliability; however, they must be used in the context of traditional visual and radiographic assessment still being the gold standards of care at present. The current development of ICCMS by a worldwide group of cariologists will use ICADAS and the current evidence base to provide information that will allow clinicians to use information such as lesion characteristics and caries risk to formulate valid treatment decisions.