Fluorescence and Near-Infrared Light Transillumination

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KEYWORDS

• Autofluorescence • Near infra-red transillumination • Early detection • Dental caries • Oral cancer • Osteoradionecrosis • Optical devices • Fluorescence technologies

KEY POINTS

- Technologies using autofluorescence of tooth and red fluorescence of bacterial metabolites for visualization and quantitative analysis of both early caries and dental plaque were discussed.
- Fluorescence-guided surgery, using devices with fluorescent light filters, aids surgeons in applying bone-preserving operative principles during surgical management of patients with osteoradionecrosis and medication-related osteonecrosis of the jaw.
- Autofluorescence devices aid in evaluation of oral mucosa for identification of premalignant and malignant lesions, and identifying the appropriate margin for tumor resection.
- The potential of novel imaging configurations such as near-infrared light reflectance and transillumination for imaging caries lesions on both proximal and occlusal surfaces of teeth were discussed.
- Evidence-based clinical practice guideline and most literature reviews recommend these diagnostic devices to be used only as adjuncts to clinical decision making.

The early detection and clinical staging of the presence, activity, and severity of a disease is of paramount importance in the deployment of treatment strategies that use either nonsurgical modalities or tissue-preserving surgical principles. Hence, it is generally recognized that the development of new technologies for the detection of

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any disease at an early stage of its formation could provide health and economic benefits, ranging from timely preventive interventions to decreased costs of surgical treatment. Thus, a variety of innovative technologies have been developed and introduced in the past few years to aid clinicians not only in early oral disease detection, but to make a firm diagnosis and treat cases conservatively. This article describes the various technologies based on either autofluorescence of body tissue or near-infrared (NIR) light illumination, tailored to aid practitioners in detecting and quantitatively monitoring oral diseases such as dental caries and oral cancer at the earliest stage of their formation, or in conservative surgical excision of necrotic bones in diseases such as chronic osteomyelitis, osteoradionecrosis (ORN), and medication-related osteonecrosis of the jaw (MRONJ). The current applications of these technologies are also discussed. The data discussed are primarily based on published scientific studies and reviews from case reports, clinical trials, and in vitro and in vivo studies. References have been traced manually, by MEDLINE, or through manufacturer's websites. Although some of the devices are fully developed and commercially available, others are still under development. The devices vary in their modes of action as well as their capability as diagnostic aids.

THE FLUORESCENCE SYSTEMS

Technologies based on autofluorescence use the alteration in natural fluorescence of a body tissue when the tissue becomes diseased to discriminate between a diseased tissue and the surrounding sound tissue.[1–9] Based on this principle, many technologies have been developed and introduced for clinical diagnosis of dental caries and oral cancer, surgical excision of necrotic bone tissues, and quantification of dental plaque.[1,8–19] However, evidence-based clinical practice guideline and most literature reviews recommend these fluorescence-based diagnostic devices to be used only as adjuncts to clinical decision making.[20–22] Particularly with the devices tailored for caries diagnosis, the output from these technologies should rarely be used to recommend surgical intervention considering the significant consequences of a false-positive or false-negative detection and diagnosis. In caries management, the inability of these devices to differentiate whether a suspected lesion is a stain, an arrested lesion, or hypomineralization precludes the use of these systems for intervention decisions. The applications of the fluorescence-based technologies in various aspects of oral disease management are discussed herein.

Application of Tissue Autofluorescence Systems in Caries Management

Fluorescence-based systems have been developed and introduced for clinical assessment, diagnosis, and monitoring of dental caries on the accessible tooth surfaces (occlusal, buccal, and lingual). These systems operate on the principle that sound tooth structure fluoresces with a distinct green color when illuminated with a specific spectrum of violet-blue light.[1] However, when the tooth enamel is demineralized (a caries lesion), the observed autofluorescence of a tooth is decreased owing to increased scattering of the incident light (**Fig. 1**).[1–3] The distribution of the green-emitting fluorophores is higher for dentin than for enamel and greatest at the dentin–enamel junction. An increase in scattering coefficient implies a decrease in mean free photon path length and hence the chance of a photon being absorbed by a fluorophore and a fluorescent photon being emitted is lowered. Where demineralization (a caries lesion) exists, the light travels shorter distances into the tooth, and the view on the dentin–enamel junction is blocked. As a result, we see a dark spot of