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ORIGINAL ARTICLE

Comparison of different caries detectors for approximal caries detection

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Abstract *Background/purpose:* Detection of approximal caries may be difficult using conventional methods including visual inspection (VI) and radiography. The purpose of this *in vitro* research was to evaluate the efficiency of light-emitting diode (LED) and laser fluorescence (LF) devices, and radiographic and visual examination in approximal caries diagnosis.
Materials and methods: One hundred and fifty-six approximal regions were evaluated. All approximal regions were investigated using LED and LF tools after radiography and VI were performed. Histological evaluation of teeth was performed using stereomicroscopy. The area under the receiver operating characteristic curve and accuracy, specificity, sensitivity values calculated regarding approximal caries diagnose.
Results: The specificity of the bitewing examination was higher for both T1 and T2 thresholds (0.97 and 0.99, respectively), and the LF device showed better sensitivity at each threshold compared with the other devices used for caries diagnosis (0.94 at T1 and 0.79 at T2). The receiver operating characteristic curves presented that the LF device was more successful than the other techniques at T1 threshold and VI was better than the other caries detection methods at T2 threshold. The kappa values for interobserver agreements were 0.43 (LF pen), 0.33 (LED device), 0.55 (VI), and 0.75 (bitewing examination).

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Conclusion: The ability of bitewing radiography to identify sound surfaces was better than that of the other methods. The LF device was the most sensitive tool for detecting approximal surfaces with caries, followed by the LED device.

Introduction

Diagnosis of the decay present on the proximal area of posterior teeth is difficult because direct visual examination cannot be applied due to the wide contact areas.[1,2] Researchers are working to develop an efficient, cost-effective, and quantitative method, with high validity and reliability, for use in approximal caries detection. An ideal method for caries detection should offer high specificity, sensitivity, and reproducibility. Although visual inspection (VI) has shown high specificity in approximal caries detection, it displays low sensitivity and reproducibility.[2–4] To develop the currency and reliability of VI, a visible scoring system (International Caries Detection and Assessment System) for caries diagnosis was developed for the surveys. However, this system has yet to be validated for approximal surfaces.[2,5]

Although radiographic methods can be more sensitive than VI in approximal caries detection, these are is not quantitative. Bitewing radiography is the standard method for detecting approximal caries. However, it underestimates the actual depth of the lesion and is more suitable for detecting dentin caries. Another limitation of this radiography is that patients are exposed to ionizing radiation.[2,4,6,7]

New adjunct devices, such as a laser fluorescence pen (LF pen; Kavo, Biberach, Germany), have been proposed in the past number of years to increase the reproducibility and accuracy of caries diagnosis and to aid in objective assessments.[8] The LF pen device can diagnose occlusal and approximal caries by detecting the emitted fluorescence after practice of laser light emitting a wavelength of 655 nm. The LF device has shown good accuracy and reproducibility in the determination of proximal decay. Thus, the use of an LF pen in approximal surfaces has been proposed.[1,9–11] Both radiography and the LF pen have shown promise in increasing the sensitivity of approximal caries detection. Lussi et al[1] reported that the LF pen device was better than radiography in detecting approximal caries in permanent teeth. Other studies[4,12–14] also demonstrated that the LF pen was better than radiography in caries detection when used as an auxiliary method.

The Food and Drug Administration has approved another device, a light-emitting diode (LED) instrument, for the diagnosis of occlusal and approximal caries. This tool emits a soft LED light ranging from 635 nm to 880 nm. A sound tooth is more translucent than a tooth with a demineralized structure. The dissimilarity in translucency means that the optical appearance of the sound tooth is different from that of the decalcified teeth. The LED device includes a computer-based algorithm, which determines the various visual signatures of sound and demineralized teeth. This tool is based on an analysis of the projection and refraction of the emitted light from the tooth surface. The light is received by fiber optics and transformed to an electrical beam for examination.[15]

Although several *in vitro*[16–18] and *in vivo*[19] studies on the effectiveness of the LED device in detecting occlusal caries have been conducted, there are a few reports in the literature on its application to proximal caries.[20] Thus, the goal of the present investigation was to investigate the validity of the LED device in the diagnosis of approximal caries, and to compare the performance of the device with that of the LF pen and other diagnostic techniques.

Materials and methods

The current research was approved by the Gaziantep University Ethics Committee in Research, Gaziantep, Turkey (No. 03-2009/78). A total of 156 approximal surfaces of 789 teeth, making sure that they are kept in contact with the sound teeth, were evaluated in this study. Permanent molars without approximal restorations, hypoplasia, and cavitation on approximal and occlusal surfaces were selected. Teeth where it was difficult to simulate the contact point were excluded. Following extraction, the teeth were waited at −20°C and stored in individual closed containers. The teeth were not in contact with any storage solution until use. Distilled water was used in individual holders to avoid dehydration of the teeth. The teeth had no contact with the soaked roll, which provided 100% humidity in the closed holders. The stored teeth were later defrosted at room temperature for 4 hours before starting the experiment.[11]

The proximal areas were brushed with a rotating device and pumice. To imitate the proximal contact surfaces, the teeth were located in model arches and stabilized with melt utility wax. Contact areas were achieved, which were confirmed with dental floss. Each test site was assessed by two examiners.

A photostimulable phosphor plate system was introduced (Vista Scan Mini; Dürr Dental AG, Bietigheim-Bissingen, Germany) to acquire digital bitewing radiographs of the teeth. They were exposed for 0.6 seconds at 60 kVp, 10 mA, focus to distance 20 cm, using an X-ray unit (Trophy; Kodak, Rochester, NY, USA) for standardization. The bitewing radiographs were scored as follows: D0, no radiolucency; D1, radiolucent area in the enamel; and D2, radiolucent area in the dentin.[4]

After radiographic evaluation, VI was performed without removing any teeth from the arch. The specimens were placed at a distance of about 30 cm from the examiners' eyes. The specimens were evaluated using no