Detectar™: A Novel LED-based Optical Probe for Subgingival Calculus Detection

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Non-surgical therapy, including supra- and subgingival scaling and root planing is one of the most important means of treating periodontitis. The objective of subgingival instrumentation in periodontally diseased sites is to remove the adhering microbial biofilm and calcified deposits and to create a clinically smooth root surface in order to promote a healing response in the gingival tissues. However, total removal of calculus is a difficult task. Following debridement of the periodontally involved root surface, the thoroughness of calculus removal is traditionally evaluated using a periodontal probe. The main failure in periodontal treatment may depend on calculus remaining after therapy. Recently, a novel measurement device has been introduced. The Detectar™-system is designed for objective subgingival calculus diagnosis. By evaluating the root surfaces with LED light and detecting differences between calculus and the root surface, the endpoint of root surface instrumentation might be assessed more precisely.

Key words: Detectar™, subgingival calculus detection, LED light

The principal objective of periodontal therapy is the conservative elimination of soft and hard bacterial deposits on the root surface and to prevent recolonization of periodontal pockets by pathogenetic bacteria (Cobb, 1996; Van der Weijden et al, 2002). The rationale for the complete elimination of calcified hard deposits is based of the etiology of chronic destructive periodontal diseases. The beneficial effects of subgingival calculus removal on gingival health, pocket depth and attachment levels have been documented in numerous clinical studies and in histological reports (Isidor et al, 1984; Jones et al, 1972; Pihlstrom et al, 1997). Therefore, the initial hygiene phase is fundamental to successful periodontal therapy without causing root damage (Mandel et al, 1986; Schenkein, 1999).

Currently, the thoroughness of subgingival root debridement is determined by the degree of smoothness and hardness of the root surface. Studies related to root planing have shown that complete removal of calculus might be difficult (Sherman et al, 1990). Following debridement of the periodontally involved root surface, the clinician traditionally evaluates the endpoint of root surface instrumentation with a probe or curette and has to rely on his tactile sense (Clerehugh et al, 1996; Low, 1995). Distinguishing between the existence of calculus and aberrations in the morphology of the root surface may be difficult or impossible (Rabbani et al, 1981; Sherman et al, 1990) and it is not always possible to prevent loss of root substance free of calculus. Due to cumulative effect, substance removal per scaling may result in severe root damage over time (Zappa et al, 1991). Incomplete removal of subgingival calculus may be responsible for a high percentage of treatment failures.

Clearly, there is a need for the development of alternative methods to assist with the detection of residual calculus (Pippin et al, 1992). One experimental detection system is based on measurements of resonance vibrations of ultrasonic treatment (Kocher et al, 2000). Another technology based on the occurrence of fluorescence light was

Fig. 1 The Detectar™-measurement device.

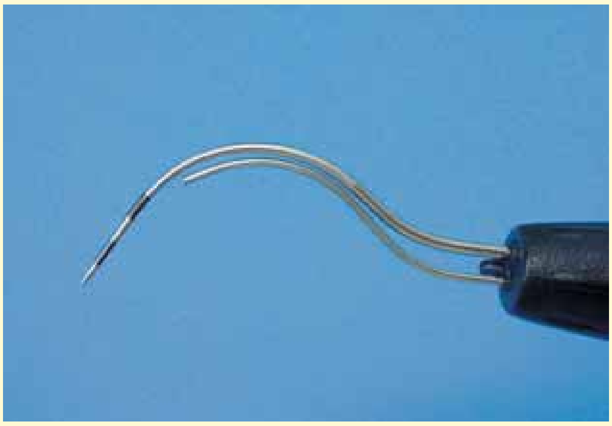

Fig. 2 Probe of the Detectar™-system.

Fig. 3 Maintenance and calibration kit comprising testing standards and polishing pads.

Fig. 4 The diameter of the Detectar™-probe (right) is the same as that of a conventional periodontal probe (left). Both instruments show graduations of 3 mm.

primarily developed for caries diagnosis (Hibst et al, 1998) but also seems to be suitable for calculus detection (Folwaczny et al, 2002; Krause et al, 2003). Recently, a novel calculus detection system called Detectar™ employing spectrooptical technology has been developed.

The Detectar™-system

The Detectar™-system (Ultradent, Salt Lake City, USA) (Fig. 1) is designed for objective subgingival calculus diagnosis by evaluating the root surfaces and detecting differences between calculus and the root surface. This new technology relies on light emitting diodes (LEDs). Dental calculus demonstrates a specific spectral signature when illuminated with a specific selection of wavelengths. This spectral signature is different from that of other structures such as dentin, cementum, soft tissues, subgingival fluids and blood (Benhamou, 2003). Light is emitted to the root surface through a flexible fiber. Reflections of this LED light are also sensed by the optical fiber and converted into an electrical signal for analysis. A computer processing algorithm determines whether the Detectar™-probe has found calculus and activates both an auditory and light signal to notify the clinician of the presence of the calculus.

The Detectar™-system is a portable device. The kit contains a universal base unit with probe (Fig. 2), foot pedal, and maintenance and calibration unit (Fig. 3). The tip of the probe has the same dimension as periodontal probes and contains graduated markings in intervals of 3 mm (Fig. 4). The

Fig. 5 System self-check: Tip of the probe placed on the testing standard. Single, brief tone: The system is ready for use. Multiple tones: The system is not ready for use.

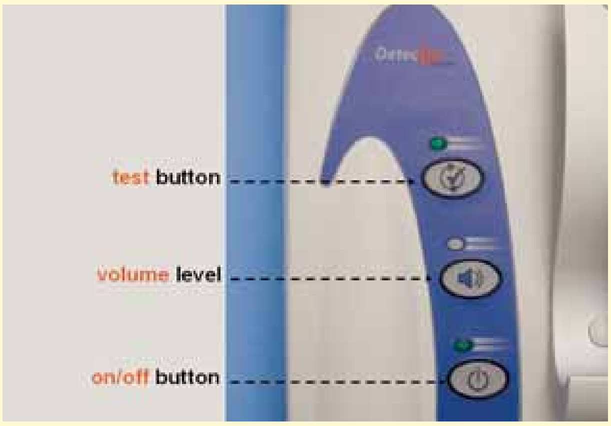

Fig. 6 Control panel of the Detectar™-system.

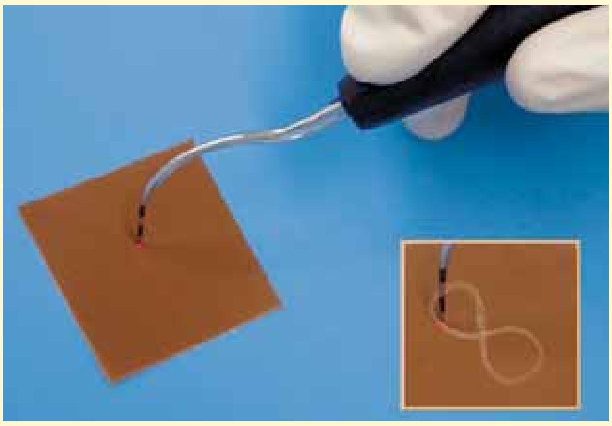

Fig. 7 Polishing of the Detectar™-probe. The tip is hold vertically in contact with the polishing pad. The polishing procedure is performed in a figure of eight (''8'') motion (detail).

probe is removable and sterilizable at 135 °C in an autoclave. The device's surfaces, cords, cables and connectors can be cleaned with a suitable surface disinfectant solution. Before taking any measurements, it is necessary to perform a system self-check with a testing standard to ensure a proper probe operation. This involves placing the tip of the probe on the testing standard included in the maintenance and calibration kit (Fig. 5). The system is ready to use when a single, brief tone is emitted while pressing the test button (Fig. 6). Otherwise, when multiple tones are emitted, all connections must be checked and / or the probe may require cleaning with the polishing pad (Fig. 7). The Detectar™-system has an optional water supply feature and an irrigation control. Water is not essential for the system to operate. However, irrigation of the periodontal pocket may help by reducing the frequency of cleaning the tip during use. The Detectar™-system can be activated with a foot pedal with two active positions: control of the Detectar™-probe, and water flow. The probe is handled like a conventional periodontal probe, using a 10°–15° angulation with slow vertical motions along the root surface in contact mode. In the presence of subgingival dental calculus, the unit beeps and flashes a small green on the device's hand piece. The volume level of the sound signal is adjustable (high, normal or no sound) (Fig. 6).

At present, there are no peer reviewed original articles evaluating the reliability of this detection system. The possibility of detecting subgingival calculus depending on different tip angulations and fluids covering the root surface was evaluated in an in-house *in vitro* study. The results indicate that clinically and histologically apparent calculus on the root surface is accompanied by positive measurement values using both blood and physiological saline solution as ambient fluids (Krause et al, 2003).

CONCLUSIONS

Up to now, dental calculus detection is performed manually and depends on a clinician's expertise, experience and dexterity. The Detectar™-system offers the possibility for objective subgingival calculus detection by allowing accurate detection of residual deposits and may reduce root surface damage by non-specific scaling and root planing. The device might establish a reliable endpoint for periodontal therapy. Further *in vivo* studies are necessary to evaluate the reliability of this detection system under clinical conditions.

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