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Sequelae of Dental Endoscope in Non-Surgical Periodontal Therapy

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ABSTRACT
Direct, real-time visualization of the hard and soft tissues within the gingival sulcus may aid the clinician in diagnosis and therapy of periodontal disease. This report describes an endoscope specifically designed for this purpose and the interpretation of dental endoscopic images. The dental endoscope gives the clinician direct, real-time visualization and magnification of the subgingival tooth root surface, aiding in the location of deposits on the tooth root. The subgingival soft tissue, including the gingival attachment, sulcus wall, and sulcus contents, can be assessed. Identification and location of subgingival caries, root fractures, tooth root deposits, post perforations, and open restoration margins may aid the clinician in diagnosis and therapy.

Keywords :Endoscope, Non-Surgical Periodontal Therapy, Periodontitis, Scaling And Root Planing

I. INTRODUCTION

Although scaling and root planing are central to the treatment of most periodontal diseases, the inability of the clinician to completely scale and root plane the majority of the subgingival root surface has been repeatedly demonstrated.[1-8] This is due in part to the difficulty of detecting some root deposits and to restricted access to root deposits.[2-4] Calculus has been shown to contain viable and non-viable bacteria, as well as bacterial products that induce a host response and can initiate and perpetuate periodontal infection.[9-10] In the presence of poor oral hygiene, teeth with subgingival calculus demonstrate a higher rate of attachment loss than teeth without such deposits.[11]

Visualization of root surfaces during instrumentation may improve scaling and root planning efficiency. Evaluation of subgingival root deposits, caries, root fractures, and soft tissues is crit- ical to diagnosis, treatment planning, delivery, and evaluation of therapy. Non-invasive examination of the hard and soft tissues of the subgingival sulcus has been primarily restricted to tactile exploration or radiographs. Additionally, traditional SRP is limited by lack of access to identify residual calculus, decreased efficiency in calculus removal at deeper sites, and operator experience.[12-14]

Non-invasive imaging of tissues and body structures with the aid of ultrasonics, magnetic resonance imaging (MRI), and computed tomography (CT) is common- place in medicine and to a lesser extent in dentistry[15]. Virtual-reality technology gives the physician real-time 3-dimensional projection of structures with non-invasive techniques of computed MRI. With the exception of computed tomography, none of these techniques has a current application in dentistry.

Recent advancements in fiber optic technology, coupled with modifications of the standard curet, periodontal probe, and ultra-sonic scaler, have led to the development of an instrument which allows the clinician direct vision of the subgingival margin sulcus contents. the effectiveness of traditional SRP also has been limited by the operator's inability .To detect residual calculus accurately by visualization [16-18] or by tactile sensation[19.]

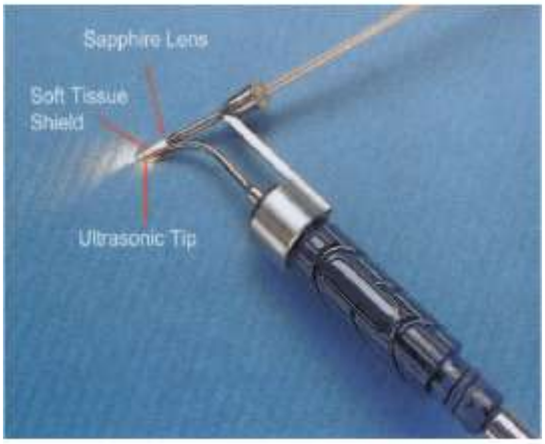
DENTAL ENDOSCOPE:

Endoscope is derived from the Greek words "endo" meaning "inside" and "skopeein" meaning "to see." In general, an endoscope has an input image lens located at the distal tip of the device, an image transmission system for relaying the image outside the body, an ocular to magnify and refocus the image for viewing by the eye, and a transmission system to provide illumination from a remotely located lamp. These elements are contained within a rigid or flexible tube. Endoscopes may also have a prism in front of the input lens to alter the direction of view and a video camera attachment to allow the user to view the endoscope image on a video monitor rather than directly viewing the image through an ocular. One or more channels may exist for the introduction of air, water, surgical instruments, probes, etc. A mechanical system may allow the tip of the endoscope to be articulated.

Current technologies available for endoscopes include input lenses, which can be conventional discrete lenses (as in a camera or microscope) or gradi- ent index lenses (glass rod with radially varying index of refraction). The image transmission system can be a stack of discrete lenses (relay lenses), gradient index rod (longer version of gradient index lens), fiber optic bundle (many thousands of individual fiber optic strands), or fused fiber optic bundle (many thousands of individual fiber optic strands fused in a matrix of glass). Each of these technologies has advantages and disadvantages, which must be considered in light of thespecific application.

Fiber optic endoscopes contain bundles of thin glass fibers that use the principle of total internal reflection to transmit light to and from the organ being viewed and to transmit almost 100% of the light entering one end to the other end. Fiber optic endoscopes are del- icate and expensive instruments.

COMPONENTS OF DENTAL ENDOSCOPE



A family of dental instruments including curets, explorers, and an adapter for ultrasonic scalers has been designed to accept the imaging system.

Curettes

A stainless steel formed tube was welded to the shank of the curet near the cutting blade . This tube is designed to accept the endoscope (with window sheath) and to hold the distal end of the endoscope in a precise location. This tube also directs irrigation fluid delivered by the attached endoscope/ window sheath onto the blade of the curette.

A gingival retractor (soft tissue shield) was added to the blade of the curet. This retractor holds the gin- gival tissue away from the tip of the endoscope, pro- viding a clear view of the curet blade and adjacent tooth surface.

Explorer/Probe

The explorer/probe is a stainless steel tube welded to a handle . This tube accepts the endoscope/win- dow sheath. The distal tip was shaped to provide a gin- gival retractor. This tube also directs irrigation fluid deliv- ered by the attached endoscope/window sheath onto the retractor.

Ultrasonic Adapter

The ultrasonic adapter, constructed of stainless steel collar, strut, and tube, was welded together into a sin- gle unit. The stainless steel collar fits into the end of a standard ultrasonic scaler and is locked in position with a screw. When positioned and locked into place, the tube is positioned along side of the scaler tip.

Endoscope

A flexible endoscope design was selected for use with the dental instruments. The endoscope has a gradient index lens located at its distal end. The lens is mounted on the end of a 2 m long fused fiber optic bundle con- taining 10,000 individual light guiding fibers (pixels). Surrounding the fused bundle and lens are 15 large core plastic fiber optic strands for carrying illumination light from a remote lamp to the operative site. The lens, image transmitting fiber, and illumination fibers are incased in a flexible plastic tube.

The water is carried to the distal end where it sprays out and clears the viewing field. The window sheath also is fitted with a small plastic connector plug at its distal end, which fits into a mating stainless steel receptacle built into each instrument (curet, explorer, and ultrasonic adapter). This plug allows for precise positioning of the endo- scope tip relative to the working end of the instrument. The dental endoscope is provided with a standard peristaltic pump for delivery of irrigation fluid, via the window sheath, to the attached instrument and, sub- sequently, working field. The high-output lamp is equipped with a fif ber optic cable that carries the light to the endoscope.

Within the endoscope are 15 light

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fibers that carry the light to the endoscope's distal end, which exits at the distal end and illuminates the working field.

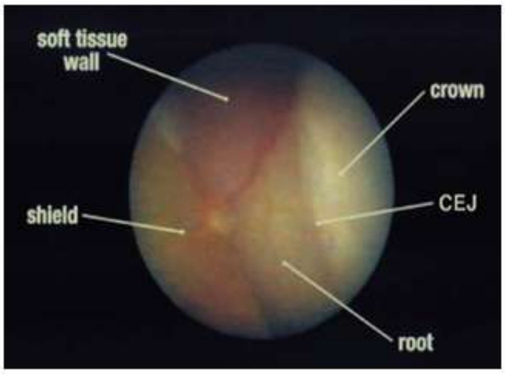
The endoscope is connected to a medical grade CCD video camera via a camera coupler. The camera coupler magnifies and focuses the image transmitted by the endoscope onto the CCD image sensor of the camera. As with all CCD cameras, the light is con- verted to electrical signals by the CCD sensor. The electrical signals are transmitted to the camera con- trol unit, which digitizes the signal and applies various processing signals (gain controls, white balances, etc.).

MAGNIFICATION OF DENTAL ENDOSCOPE

The objective lens of the endoscope has a nominal 70° field of view in air. The distance from the endoscope lens to the extreme tip of the explorer and the ultrasonic tip is 4.5 mm. The image that is projected onto the monitor is always a round image with the field of view varying between 2.4 to 6.6 mm in diameter. The magnification on the monitor can be from 46x to 15x depending on the distance of the object from the tip of the endoscope. The magnification, for example, at the cutting edge of the curette is 24x. The clinician must keep in mind that the images are highly magnified.

ORIENTATION

The instrument has a retractor to displace the soft tissue away from the field of view. With the probe/explorer, half of the screen will be the retractor with a bright reflection on both outer edges of the shield. The curette retractor will look like a curette tip extending about a third into the field of view. By training the eye to locate the retractor first, the clinician can make the mental adjustments for magnification, relative motion, and orientation.



These images are reproduced from a digital video recorder attached to the video monitor for the endoscope. They are unaltered photographs made from digital tape, downloaded to a computer hard drive, and labeled. Prints are produced from the computer image. The clinician should first locate one or more of the following anatomical landmarks: crown of the tooth, cemento-enamel junction (CEJ), soft tissue of the gingival sulcus, or the instrument shield.

The sulcus depth is 6 mm and the perspective is one of looking down the root surface at approximately 45°. A small band of inflamed tissue adjacent to a moderate amount of plaque on the root surface can be observed. Once these are identified, the endoscopic instrument should be moved slightly to establish perspective, focus, orientation, and a sense of motion of the instrument relative to the landmarks identified.

II. DISCUSSION

The results from this study indicate that there is a statistically significant decrease in the percentage of residual calculus present after SRP with the periodontal endoscope compared to SRP alone on overall tooth surfaces, buccal/lingual surfaces, and interproximal surfaces. For buccal/lingual and interproximal surfaces, there was no difference in percentage of residual calculus between test and control treatments at shallower PD. Conversely, at deeper PD, use of the periodontal endoscope resulted in significantly less residual calculus.

The inability of the clinician to completely scale and plane the majority of the root surface apical to the gingival margin has been repeatedly demonstrated.[1-8] This is thought to be due, in part, to failure of the clinician to detect some root deposits and to restricted access to root deposits. The dental endoscope provides direct vision of the subgingival margin root surface and may provide the clinician with the ability to locate and evaluate the extent and nature of subgingival root deposits.

Not all sites are accessible for viewing and instrumentation with a dental endoscope. However, preliminary studies indicate that up to 95% of all root surfaces may be accessed for visualization with the instrument.[20]

In addition ,root deposits that are not accessible to non-surgical root instrumentation occasionally viewed, and these sites may require surgical intervention.

III. CONCLUSION

There was a statistically significant decrease in percentage of residual calculus at sites treated with SRP and adjunctive use of the periodontal endoscope compared to sites treated with closed SRP alone. With respect to PD at the treated sites, differences between SRP with and without the endoscope were significant only at deeper sites (>4 mm for buccal/lingual surfaces and>6 mm for interproximal surfaces).

The dental endoscope gives the clinician direct, real- time visualization and magnification of the subgingival margin root surface, deposits on the root, soft tissue, including the gingival attachment, and sulcus contents. As operator experience increased, the treatment time using the endoscope decreased while maintaining a similar effectiveness of calculus removal.

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