A Pilot Study Comparing the Outcome of Scaling/Root Planing With and Without Perioscope™ Technology

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Abstract

Purpose: The purpose of this study was to determine if the use of a periodontal endoscope improves periodontal outcomes of scaling/root planing when compared to scaling/root planing alone.

Methods: Thirty subjects with moderate periodontitis were recruited from the University of Minnesota School of Dentistry. Of these, 26 completed the study. A randomized split mouth design was used to evaluate periodontal outcomes at 6 to 8 weeks and 3 month intervals after sites within 2 quadrants of each subject were scaled and root planed with or without the use of the Perioscope™. Paired t-tests were used to test whether there were within-patient differences in improvement between Perioscope™ and non-Perioscope™ sites as measured by periodontal measurements (probing depth, clinical attachment level) and indices of gingival inflammation, including bleeding on probing (BOP) and gingival inflammation (GI). P-values less than 0.05 were declared to be statistically significant.

Results: Less BOP and GI were found in the Perioscope™ sites at visit 1 and visit 2. Reduction in pocket depth and clinical attachment loss was achieved for all sites but probing depth and clinical attachment level changes were found to be unrelated to the use of the Perioscope™. Mean probing depth (SD) was reduced from 5.29mm (0.4) to 3.55 mm (0.8) in the Perioscope™ sites and 5.39mm (0.5) to 3.83mm (1.2) in non-Perioscope™ sites from baseline measurements to visit 2.

Conclusion: The adjunctive use of the periodontal endoscope improved periodontal outcomes with respect to gingival inflammation and bleeding upon probing. The adjunctive use of the Perioscope™ was not found to be superior to traditional scaling and root planing with regard to pocket depth reduction and clinical attachment loss.

Keywords: periodontal treatment outcomes, periodontal endoscope, periodontal disease, periodontal technology, non-surgical periodontal therapy

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Assess the use of evidence-based treatment recommendations in dental hygiene practice.

Introduction

Endoscopic technology has been developed to facilitate real-time visualization of the gingival sulcus during diagnostic and therapeutic phases of periodontal care. The first generation of the periodontal endoscope, Perioscope™ (Perioscopy Inc., Oakland, Calif) was found to have technical shortcomings and a steep learning curve.[1-4] However, new technique changes and equipment modifications have improved the reliability and a number of studies have demonstrated improved efficacy for treatment of periodontal disease.[2-5,7-10]

The primary objective of scaling and root planing is to restore periodontal health by completely removing pathogenic products that induce inflammation (i.e. biofilm, calculus and endotoxin) from periodontally involved root surfaces. Calculus has been shown to contain bacterial products that induce an inflammatory response and can perpetuate periodontal infection.[11,12] Subgingival calculus is a frequent finding in patients with chronic periodontitis and it has been demonstrated that in the presence of poor oral hygiene, teeth with calculus demonstrate a higher rate of tissue attachment loss than teeth without calculus.[11,12] Therefore, the removal of bacterial plaque and calculus from root surfaces using scaling and root planing is an essential part of periodontal therapy. Although scaling and root planing are central to the treatment of most periodontal diseases, an abundance of research has demonstrated that SRP has limitations.[13-19] For example, the effectiveness of calculus removal decreases substantially with increasing pocket depth.[14,15] Root anatomy can inhibit calculus removal with an increased prevalence of residual deposits being associated with the cemento-enamel junction, line angles and furcations. The inability to visualize or accurately detect subgingival calculus with tactile sensation also results in greater amounts of residual calculus.[16,18]

The dental endoscope was developed to facilitate visualization of the subgingival environment as an aid in diagnosis and non-surgical root debridement. Studies to date have showed that adjunctive use of the periodontal endoscope has resulted in improved visibility of deposits and calculus removal. An early study by Stambaugh et al evaluated the dental endoscope and the ability of the clinician to develop skills in using fiber optics to accurately visualize the contents of the subgingival sulcus.[1] Specified sites on 42 teeth (210 sites) were evaluated and scored with respect to root deposits and caries. The teeth were then extracted and scored by a periodontist for the same parameters (root deposits and caries) with direct magnified vision. The 2 scores were then compared. Over 95% of all root surface deposits and caries were detected with the endoscope. These results demonstrate the ability of the dental endoscope to aid the clinician in accurately viewing subgingival tissues for deposits and pathology with a high degree of accuracy. Using 15 subjects, Geisinger et al studied 50 tooth pairs.[2] Each tooth pair was randomized to receive SRP with or without the periodontal endoscope. The teeth were extracted and a stereomicroscope and digital image analysis was used to determine percent residual calculus present. Researchers concluded that the periodontal endoscope resulted in a statistically significant overall improvement in calculus removal during SRP, which was most evident in deeper probing depths.[2] In a similar companion study, Michaud et al used 30 tooth pairs and randomly assigned them to receive endoscopy-aided SRP or SRP alone.[3] The study found the use of the Perioscope™ as an adjunct to traditional SRP provided no significant improvement in calculus removal in multirooted molar teeth. One explanation for the different outcomes may be that Geisinger used only single-rooted teeth which greatly improved access, while the companion study used only molars with non-fused teeth.[3]

A limited number of studies were found to have evaluated the use of the periodontal endoscope on patients with chronic periodontitis. In a preliminary trial, Stambaugh et al studied 8 patients who had been in periodontal maintenance for 2 years but were not maintaining based on attachment loss, bleeding and inflammation.[4] Group A included all teeth in all 8 patients, group B consisted of only those sites that demonstrate 2 mm or more of attachment loss within 2 years. All patients had subgingival deposits that could not be detected tactically even when they were found with an endoscope. After instrumentation using the endoscope, the majority of sites in both groups improved with respect to gingival inflammation (GI), bleeding scores (GBI), probing depth and attachment gain.[4] Kwan treated 270 patients with moderate to advanced periodontal disease.[5] All treatment was completed in 1 visit at which time patients were given a course of systemic antibiotics. All pockets >4 mm were endoscopically debrided. Patients were seen for reevaluation and supportive treatment at 3 months and then followed every 3 months for 1 year. The results showed a reduction in probing depths for all types of teeth, particularly in posterior teeth with deep pockets. Fifty-five percent of molars with pocket depths starting at 7 to 9 mm reduced to >5 mm. Sixty-nine percent of molars with pockets ranging from 5 to 6 mm reduced to >4 mm.[5] Avradopoulos studied 6 patients and found no significant differences between SRP with and without adjunctive use of the Perioscope™ on clinical measures of plaque index, gingival index, bleeding upon probing (BOP) and clinical attachment levels when baseline measurements were compared to evaluation at one and three months post-treatment.[6]

Other investigators have examined the relationship of the subgingival tooth-borne accretions to signs of inflammation using the periodontal endoscope. Endoscopical observations by Cheeci et al found a direct relationship between BOP and presence of subgingival deposits confirming the importance of BOP as an indicator of subgingival deposits.[7] Wilson et al in 2008 and Pattison et al in 2004 found, via direct observation with the periodontal endoscope, that calculus covered with biofilm was associated with inflammation of the pocket wall to a greater degree than was biofilm alone.[9,10] Wilson, Carnio, Schenk and Myers found that histologic signs of inflammation were absent 6 months after a single course of closed subgingival scaling and root planing using the dental endoscope.[8]

Recently, Rethman and Harrel questioned why the majority of general dentists and periodontists persist in using techniques for non-surgical therapy that have remained essentially unchanged for decades in spite of new technology that promotes minimally invasive periodontal treatment.[20] To date, only a limited number of studies have examined the adjunctive use of the periodontal endoscope with SRP. To further validate the periodontal endoscope, additional clinical trials are needed to assess its benefits in improving clinical measurements of periodontal disease. The purpose of this study was to determine if the use of a periodontal endoscope improves periodontal outcomes of scaling and root planing when compared to scaling and root planing alone.

Methods and Materials

Two dental hygienist examiners underwent training and calibration in use of a dental endoscope as an aid to improve periodontal health over conventional therapy. Examiners gained knowledge and experience via Perioscope™ practice on models and patients. For calibration purposes, a convenience sample of 6 subjects with periodontitis and subgingival calculus were recruited from the University of Minnesota School of Dentistry clinics. A high percent of agreement within and between examiners was achieved for both methods. Percent inter-examiner agreement (+1) for repeated tactile measures ranged from 96.1 % to 96.7%, and 93.2% to 92.2% for repeated perioscope measures.

A convenience sample of 30 healthy adult volunteers, 18 years and older, with chronic moderate periodontitis were recruited by clinical faculty in the School of Dentistry's clinics and by using flyers posted in the School of Dentistry. The purpose of the study, the time commitment, and the risks and benefits were explained verbally to prospective subjects and written informed consent obtained. This study was approved by the University of Minnesota School of Dentistry Institutional Review Board.

Based on a 2-sided paired t-test with a 0.05 level of significance, a sample size of 30 patients was determined to be sufficient to detect a pocket depth effect size of 1.0 (mean difference=1.25 mm, standard deviation=1.25 mm) with greater than 90% power. Subjects were required to have at least 4 sites with pocket depths of 5 to 8 mm in each of 2 quadrants. Subjects were excluded if periodontal inclusion criteria were not met, if they had received prophylaxis or scaling and root planing SRP of the study teeth within 1 year prior to the study, if antibiotic premedication was required, or if they had taken antibiotics within 30 days of consent.

A randomized split mouth design was used to evaluate periodontal outcomes after sites within 2 quadrants of each subject were scaled and root planed with or without the use of the periodontal endoscope, i.e., 1 quadrant was scaled and root planed with the use of the Perioscope™ and 1 quadrant of each subject was scaled and root planed without the use of the Perioscope™. A statistical program generated a randomization table that listed the possible combination of quadrants to determine which quadrant would serve as the control or treatment quadrant. Subjects were evaluated at baseline and at 2 post-scaling and root planing visits (6 to 8 weeks, 3 months). The same examiner performed the periodontal examinations throughout the study for all subjects - attempts were made to have the same examiner perform scaling and root planning but this was not always the case. At each visit, oral health education tailored to the subjects' oral health status was provided to each subject.

Figure 1: The Tactile Calculus Index

0=absence of calculus
1=subgingival isolated flecks of calculus
2=moderate explorable detectable subgingival calculus
3=moderate to heavy ledge of subgingival calculus

(Modified from the Endoscopic Calculus Index)

Figure 2: Endoscopic Calculus Index

0=no observable calculus on root surface
1=separate flecks of calculus
2=a coalition of calculus deposits covering <50% of the visual field
3=a thick, diffuse accumulation of calculus covering >50% of the visual field

Periodontal measurements, including pocket depths, clinical attachment levels, GI (Loe and Silness, 1963) and BOP (modified sulcus bleeding index - scale 0 to 1) were taken at 6 sites before treatment and at 6 to 8 weeks and 3 month re-evaluation intervals. All probing measurements were recorded to the nearest millimeter with a manual 15 mm University of North Carolina (UNC-15) periodontal probe. Clinical attachment level (CAL) was obtained by measuring the free gingival margin to the cementoenamel junction to obtain a positive or negative number. The CAL was then calculated mathematically after the probing was completed.

Study sites in the control quadrant received ultrasonic instrumentation and instrumentation with hand curettes without the aid of the Perioscope™; treatment sites in the experimental quadrant received both ultrasonic and hand instrumentation with the aid of the Perioscope™. An ODU 11/12 explorer was used for tactile detection of calculus in both the treatment and control quadrants. In the treatment quadrant, the Endoscopic Calculus Index was used during endoscopic visualization to record the differing degrees of sub-gingival deposits (Figure 1).[9] A Tactile Calculus Index was used to determine the degree of calculus detected using tactile exploration (Figure 2). Both indices are a modification of the Greene and Vermillion index originally designed to describe supragingival biofilm. An ODU 11/12 explorer was used in both quadrants for ascertaining completion of root planing, however, the Perioscope™ was also used in the Perioscope™ quadrant for evaluation. The time allotted for both control and experimental groups depended on the amount of sub-calculus and its subsequent removal by the clinician.

Statistical Analysis

Descriptive statistics (mean and standard deviation) were calculated for baseline measures (pocket depth, CAL, GI, BOP). For each patient, the average of the within-site changes from baseline was calculated at each follow-up for each measure. This was done separately for Perioscope™ and non-Perioscope™ sites. At each visit, paired t-tests were used to compare changes from the baseline measures between Perioscope™ and non-Perioscope™ sites. A p-value less than 0.05 was declared to be statistically significant. The same analysis was performed at both follow-up appointments. SAS V9.1.3 (SAS Institute Inc., Cary, NC) was used for the analysis.

Results

Twenty-six subjects completed the study - 7 females and 19 males. Five subjects were in the age range of 20 to -29, 3 between 30 to 39, 6 between 40 to 49, 9 in the age range of 50 to 59 and 3 over 60. There were 202 treatment study sites and 162 control study sites. At baseline, the probing depth and other clinical measures for both treatment and control sites were found to be similar (Table I). A statistically significant difference in calculus detection between the control and treatment quadrants was found (p=0.0046). Reduction in pocket depth and gain in clinical attachment was achieved at 6 to 8 weeks and at 3 months, but probing depth and gain in clinical attachment were found to be unrelated to the use of the Perioscope™. Mean probing depth (SD) was reduced from 5.29 mm (0.4) to 3.86 mm (0.6) at visit 1 and to 3.55 mm (0.8) at visit 2 in the Perioscope™ sites. In the non-Perioscope™ sites mean probing depth was reduced from 5.39 mm (0.5) to 3.91 at visit 1 and to 3.83 mm (1.2) at visit 2. No difference in mean change in BOP was observed at visit 1, 6 to 8 weeks after treatment, between the 2 groups. However, mean change in BOP from baseline to visit 2 was greater for Perioscope™ sites when compared to non-Perioscope™ sites (p=0.036), (Table III). Mean changes in the GI were also found to be greater for Perioscope™ sites when compared to non-Perioscope™ sites at visit 1 (p=0.006) and at visit 2 (p=0.0001), (Tables II, III).

Table I: Mean (SD) of Baseline Clinical Measures (n=26)

	Perioscope	Non-Periscope
PD	5.29 (0.35)	5.39 (0.53)
CEJ	1.55 (0.96)	1.50 (0.78)
CAL	3.74 (1.07)	3.88 (0.93)
GI	1.88 (0.41)	1.66 (0.40)
BOP	0.88 (0.23)	0.87 (0.31)
Calculus Indices	2.21 (0.52)	0.41 (0.66)

Table II: Change from Baseline in Measures at Visit 1

	n	Perioscope	Non-Periscope	Difference	p-value
PD	26	-1.43 (0.64)	-1.48 (0.61)	0.06 (0.71)	0.6825
CEJ	26	-0.40 (0.85)	-0.25 (0.81)	-0.15 (0.61)	0.2299
CAL	26	-1.03 (1.04)	-1.23 (0.76)	0.21 (0.88)	0.2449
GI	26	-0.80 (0.57)	-0.44 (0.59)	-0.36 (0.60)	0.0060
BOP	26	-0.26 (0.37)	-0.26 (0.38)	0.00 (0.49)	0.9988

Table III: Change from Baseline in Measures at Visit 2

	n	Perioscope	Non-Periscope	Difference	P-value
PD	26	-1.74 (0.64)	-1.56 (0.79)	-0.18 (0.67)	0.1710
CEJ	26	-0.50 (0.80)	-0.55 (0.61)	0.05 (0.65)	0.7144
CAL	26	-1.25 (0.81)	-1.01 (0.83)	-0.23 (0.81)	0.1575
GI	26	-1.08 (0.55)	-0.56 (0.60)	-0.52 (0.59)	0.0001
BOP	25	-0.45 (0.37)	-0.25 (0.41)	-0.20 (0.44)	0.0360

Discussion

Controlled studies examining the benefit of periodontal endoscopy are limited and results are mixed. However, this study and other studies using periodontal endoscopy, support previous research, not involving periodontal endoscopy, advocating complete deposit removal on root structures in order to reduce chronic gingival inflammation following periodontal treatment.

The results of this study support existing evidence that the periodontal endoscope allows the clinician to visualize subgingival root surfaces, therefore aiding in the determination of factors perpetuating chronic periodontal disease. The sites treated with the adjunctive use of the Perioscope™ were found to have a significant decrease in residual calculus at both re-evaluation visits due to visibility of the root surface. Our findings confirm those of Checci et al, Wilson et al and Pattison et al that when BOP is present after non-surgical periodontal therapy, a higher probability of residual deposits can be assumed.[7,9,10]

Calculus has been shown to contain bacterial by-products that induce a host response and can perpetuate periodontal infection. Therefore, instrumentation should not only be aimed at biofilm removal but complete calculus removal as well. Professional periodontal maintenance and meticulous self-care will often suffice to maintain health at sites that have responded well to traditional SRP. However, areas with unresolved inflammation caused by incomplete debridement often will progress over time. Recolonization of pathogens on residual calculus occurs rapidly enough to sustain inflammation in these non-responsive sites. The results of this study support that when residual calculus is removed, resolution of inflammation and healing is more likely to occur.

Although an overall decrease in pocket depth in all sites in this study was achieved, it was not statistically significant when compared to the control sites. This result was unexpected as the investigators hypothesized that there would be improvement on all clinical parameters similar to Kwan's findings.[5] Patient populations may provide an explanation as to why this occurred. Patients in Kwan's study were patients of record and may have been more compliant with oral self-care recommendations. Patients in this study were transient and overall motivation and compliance with oral health recommendations was very low. Additionally, in Kwan's study, patients were given systemic antibiotics during the course of their treatment.

New technology and treatments that have the potential of reducing periodontal inflammation need to be investigated. More studies are needed to examine the adjunctive use of the periodontal endoscope with SRP compared to scaling alone on clinical parameters and to compare the effectiveness of calculus removal in non-surgical therapy with endoscope visualization to direct visualization during surgical access. Additional research is needed to determine if adjunctive use of the periodontal endoscope with SRP compared to SRP alone results in clinical improvement over time.

Limitations

Limitations to this study include:

- Subject selection, in that, although all subjects met the inclusion criteria, different results may have been achieved with patients with differing levels of disease
- Examiner experience with the periodontal endoscope as the different results obtained from various studies may be a reflection of operator experience

Conclusion

This study supports the current body of evidence that the periodontal endoscope allows the clinician to visualize subgingival root surfaces, therefore aiding in the determination of factors perpetuating chronic periodontal disease. A statistically significant greater decrease in gingival inflammation and bleeding upon probing at the sites treated with SRP and adjunctive use of the periodontal endoscope was achieved. Reduction in pocket depth and clinical attachment loss was also achieved however, no statistically significant differences in pocket depth reductions or clinical attachment levels were found between scaling and root planing and scaling and root planing with the adjunctive use of Perioscopy™.

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