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Effectiveness of Er:YAG Laser Therapy in Periodontal Patients

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The purpose of *Linking Research to Clinical Practice* is to present evidence-based information to clinical dental hygienists so that they can make informed decisions regarding patient treatment and recommendations. Each issue will feature a different topic area of importance to clinical dental hygienists with A BOTTOM LINE to translate the research findings into clinical application.

Microbiological findings after periodontal therapy using currettes, Er:YAG laser, sonic, and ultrasonic scalers. Journal of Clinical Periodontology. 34(7):588-98, 2007 Jul.

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Abstract

Objective. To evaluate and compare the microbiological effects of hand instruments, Er:YAG-laser, sonic, and ultrasonic scalers in patients with chronic periodontitis. Patient perception of each treatment was documented.

Methods and Materials. From 72 patients, bacterial samples were collected from the deepest pocket in each quadrant (total: 288 sites). A polymerase chain reaction kit estimated the amount of *Aggregatibacter (Actinobacillus) actinomycetemcomitans (Aa)*, *Porphyromonas gingivalis (Pg)*, *Prevotella intermedia (Pi)*, *Tannerella forsythensis (Tf)*, and *Treponema denticola (Td)* at baseline as well as 3 and 6 months after therapy. One quadrant in each patient was randomly assigned to currettes (H-group), Er:YAG laser (L-group), sonic device (S-group), or ultrasonic device (U-group).

Results. Three months post-operatively, the amounts of Pg, Pi, Tf, and Td were significantly reduced in all groups. Laser and sonic instrumentation failed to reduce Aa. Six months after therapy, significant differences were still detected for Pg (L- and U-group), for Pi and Tf (S-group), and for Td (L-, S- and U-group). Patients rated ultrasonic treatment as more preferable than hand and laser instrumentation.

Conclusion. The various treatment methods resulted in a comparable reduction of the evaluated periodontal pathogens, and bacterial increase was only partially different 6 months post-operatively. Ultrasonic instrumentation caused less discomfort.

Commentary

Over the past several years, laser therapy has been recommended as an alternative to traditional periodontal treatments such as scaling and root planing based on the assumption that lasers eradicate subgingival periodontal pathogens and inactive bacterial toxins from cementum. While many clinicians have embraced these procedures, little empirical evidence exists to support effectiveness of lasers in this regard or their advantage over traditional therapy. Consequently, this study was designed to evaluate the microbiological effects of Er:YAG laser, hand, ultrasonic, and sonic scaling. Specifically, researchers were interested in the effectiveness of these treatment modalities on reductions of 5 periodontal pathogens: *Aggregatibacter* (formerly *Actinobacillus*) *actinomycetemcomitans* (Aa); *Porphyromonas gingivalis* (PG); *Prevotella intermedia* (PI); *Tannerella forsythensis* (Tf); and *Treponema denticola* (Td). In order to qualify for participation, healthy subjects had to have moderate periodontitis defined as having at least 1 pocket in each quadrant with ≥ 4 mm of bone loss. Once recruited, subjects participated in a 3 to 5 week pre-trial oral hygiene phase in which oral hygiene procedures were mastered, and caries/defective restorations/pulpal pathology were eliminated to reduce the oral microbial load.

Seventy-two subjects were clinically and microbiologically assessed at baseline, and one site in each quadrant (within individual) was randomly assigned to be treated with one of the 4 treatments: laser, sonic, ultrasonic, or hand instrumentation. This 4 quadrant design, in which each subject contributes 4 sites, one site to each treatment modality, effectively removes other competing explanations related to treatment differences since each subject acts as their own control. Microbiological assessment and PPD were accomplished again at 3 months and 6 months post-treatment, and subjects were queried about their perception of pain, unpleasantness, and inconvenience experienced during therapy. A single blind examiner performed all clinical measurements and microbiological assessments. Examiner consistency was assessed and this individual demonstrated a $> 90\%$ agreement in obtaining PPD measurements. Microbiological samples were obtained from sites in each of the 4 quadrants using a sterile paper point, and identification of species was performed using polymerase chain reaction (PCR)/ DNA probe test.

In order to ensure maximal efficiency of the treatment interventions, all treatments were rendered under local anesthesia by the same clinician within a 24-hour period. Hand, sonic, and ultrasonic instrumentation was performed until the clinician was satisfied that root surfaces were debrided and planed. Laser instrumentation was performed until the laser's detection system indicated the root surfaces were free of deposits. The average time required to instrument single rooted teeth was 6.5 minutes, 9.7 minutes, 7.3 minutes, and 8.2 minutes for laser, hand, sonic, and ultrasonic, respectively. For multirooted teeth, times were considerably greater at 11 minutes for laser, 15 minutes for hand, 13 minutes for sonic, and 15 minutes for ultrasonic. Over the remaining 6 months, patients received a dental prophylaxis every 2 weeks for the first 3 months, and then once a month for the remaining 3 months of the trial.

Overall, the results indicated that there were few differences between the 4 treatment modalities for most of the periodontal organisms. While Aa was reduced significantly for hand and ultrasonic instrumentation at 3 months, this effect was not sustained at the 6-month evaluation. For Tf, Td, Pi, and Pg, all treatment resulted in a significant reduction from baseline at 3 months. However, at 6 months, only Pg was different from baseline for the laser and ultrasonic treatments, whereas Pi and Tf were less than baseline only in the sonic group. Td was significantly less from baseline in all groups. It is most noteworthy that none of the treatments resulted in a total eradication of the organisms. With respect to perception of discomfort, sonic scaling was rated as less uncomfortable than either hand or laser instrumentation immediately after treatment and one month later. In addition, hand scaling was rated as worse than sonic and ultrasonic instrumentation. No summary data were provided for change in PPD over time.

This study used an efficacy approach to examine whether there were differences in microbiological effects from the 4 nonsurgical treatments. Efficacy studies evaluate therapeutic outcomes when treatments are rendered under "ideal conditions". In this case, instrumentation time per tooth was fairly extensive, and the supportive therapy delivered over the 6-month period was intended to provide the best possible infection control. In spite of this, the microbial reductions observed at 3 month were not sustained at 6 months. The authors suggest that this rebound effect may be partially attributable to the ability of periodontal pathogens to invade and form reservoirs within the surrounding periodontal tissues. They also suggest

that these pathogens may also remain viable in dentinal tubules and niches on the root surfaces, as well as at other oral sites such as tongue, mucosa, and tonsils, allowing for repopulation over time. One can certainly argue that if differences were not observed between therapies under these relatively ideal conditions, it is highly unlikely that one would observe differences under typical clinical conditions. Apparently, hand, sonic, ultrasonic, and laser nonsurgical treatments provide similar efficacy on reducing subgingival microbial load. It is notable, however, that the research subjects in this clinical trial, who experienced each of the 4 treatments in different quadrants, clearly rated ultrasonic instrumentation as more pleasant, and less painful/inconvenient compared to hand and laser therapy. As dental hygiene clinicians, providing competent care that is acceptable to patients is always a primary goal. This study provides good evidence that can be applied in the clinical setting.

Short-term clinical and microbiologic effects of pocket debridement with an Er:YAG laser during periodontal maintenance. Journal of Periodontology. 77(1):111-8, 2006 Jan.

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Abstract

Background. The erbium-doped:yttrium, aluminum, and garnet (Er:YAG) laser is considered a useful tool for subgingival debridement because the laser treatment creates minimal damage to the root surface and has potential antimicrobial effects. The aim of this randomized controlled clinical trial was to evaluate clinical and microbiologic effects of pocket debridement using an Er:YAG laser in patients during periodontal maintenance.

Methods. Twenty patients at a recall visit for maintenance were consecutively recruited if presenting at least four teeth with residual probing depth (PD) $>$ or $=$ 5 mm. Two pockets in each of two jaw quadrants were randomly assigned to subgingival debridement using 1) an Er:YAG laser (test) or 2) an ultrasonic scaler (control). The laser beam was set at 160 mJ with a pulse frequency of 10 Hz. Clinical variables were recorded at baseline, 1 month, and 4 months after treatment. Primary clinical outcome variables were changes in PD and clinical attachment level (CAL). Microbiologic analysis of subgingival samples was performed at baseline, 2 days, and 30 days after treatment using a checkerboard DNA-DNA hybridization technique against 12 periodontal disease-associated species.

Results. The mean initial PD was 6.0 mm (SD: 1.2) in the test group and 5.8 mm (SD: 0.9) in the control group. At 1 month post-treatment, the PD reduction was significantly greater for test than control sites (0.9 versus 0.5 mm; $P < 0.05$). The CAL gain also was significantly greater (0.5 versus 0.06 mm; $P < 0.01$). At the 4-month examination, no significant differences were detected in PD reduction (1.1 versus 1.0 mm) or CAL gain (0.6 versus 0.4 mm). Both treatments resulted in reduction of the subgingival microflora. No significant differences in microbiologic composition were identified between the treatment groups at various time intervals. Degree of treatment discomfort scored significantly lower for the test than the control treatment modality.

Conclusion. The results of the trial failed to demonstrate any apparent advantage of using an Er:YAG laser for subgingival debridement, except less treatment discomfort perceived by the patients.

Commentary

As with the previous study, this team of researchers investigated whether there were any clinical or microbiological differences between teeth treated with the Er:YAG laser or ultrasonic scaling. In this study, a single examiner, who was blind as to treatment group, evaluated Plaque, Probing Pocket Depth (PPD), Bleeding on Probing (BOP), Clinical Attachment Level (CAL), Dentin Sensitivity, and Perception of Discomfort at baseline, 1 month, and 4 months after treatment. In addition, the following periodontal pathogens were assessed by DNA probe before treatment, 2 days after treatment, and 1 month following treatment: *Porphyromonas gingivalis* (PG); *Prevotella intermedia* (PI); *Tannerella forsythensis* (Tf); *Aggregatibacter* (formerly *Actinobacillus*) *actinomycetemcomitans* (Aa); *Fusobacterium nucleatum* (Fn); *Treponema denticola* (Td); *Peptostreptococcus micros* (PM); *Campylobacter rectus* (Cr); *Eikenella corrodens* (Ec); *Selenomonas noxia*

(Sn); and *Streptococcus intermedius* (Si). Twenty healthy subjects with moderate periodontitis (defined as having at least 4 nonadjacent teeth with > 5mm pocket depths in 2 quadrants) who had not had any periodontal instrumentation in the past 6 months, participated in this trial. The 2 sites in each quadrant were randomly assigned to receive either laser or ultrasonic subgingival therapy following baseline assessment of clinical and microbiological parameters. All treatment was provided by a dental hygienist, who was trained in use of both the laser and ultrasonic devices, at a single visit. Instrumentation was performed on each site until either the laser detection system indicated that the surface was clean (for laser-treated teeth) or the clinician judged that root surfaces were adequately debrided. The average treatment time for the 2 sites treated with laser was 3.6 minutes (SD = 1.3) compared to 4.0 minutes (SD = 1.1) for ultrasonic instrumentation. No anesthesia was provided to the subjects during this study, however, 0.12% chlorhexidine oral rinse was provided for 1 week post-instrumentation.

Change in BOP from baseline to 4 weeks was virtually identical between the 2 treatments, and decreased from 92% at baseline to 60% and 40%, at 1 and 4 months, respectively. For PD and CAL, both groups showed a statistically significant improvement compared to baseline. At 1 month post treatment, there was a slight (less than 0.5 mm), but statistically significant advantage for the laser treated sites for PD reduction and CAL gain, however, this advantage was no longer evident at the 4-month evaluation period. With regard to periodontal pathogens, 3 of the microbial species (*Cr*, *Ec* and *Sn*) were not found at any time point. A comparison of other periodontal pathogen between laser and ultrasonically treated sites showed no difference in levels at either 2 days or 1 month post treatment. Consistently, there was a reduction in all species over time with a slight tendency favoring ultrasonic scaling. Considering only the "red complex" organisms (those organisms most strongly associated with periodontitis - *Pg*, *Tf*, and *Td*), there was a statistically significant reduction at 2 days post treatment for both treatment modalities, however, no differences were observed for sites treated with laser versus ultrasonics. Subjects reported a higher level ($p < .05$) immediately following instrumentation, but discomfort at one month was low for laser and ultrasonic treated sites.

This study failed to show that the Er:YAG laser (which was also equipped with a calculus detection system) provides any clinical advantage to ultrasonic scaling when used in an "effectiveness study." An "effectiveness study" compares therapeutic interventions in settings that more closely approximate normal clinical care. The instrumentation time for both laser and ultrasonic treated sites in this study was more typical of the time normally allotted for nonsurgical periodontal treatment in a private dental office. One might argue that providing both interventions without local anesthesia may reduced thoroughness of instrumentation, and thus attenuate any treatment effects. As 40 of the 50 United States currently allow dental hygienists to administer local anesthesia, this indeed may be a limitation to whom, and under what conditions, these results may be generalized. While laser manufacturers claim that the Er:YAG laser has the potential to eliminate subgingival microbes and remove endotoxin from root surfaces, results from this study suggest that this claim is unwarranted. The authors are quick to note that use of DNA probe allows for assessment of bacterial genetic material, not viability, and further suggest that future studies may wish to culture organisms to determine if various non-surgical periodontal treatments differentially affect periodontal pathogen viability.

The Bottom Line

In the past decade, use of lasers in dental practice has become more common. As dentists may invest upwards of \$20,000 for these devices, they often fall prey to outrageous claims that the laser "sterilizes" pockets or provides clinical outcomes equivalent to surgery. As a result, dental hygienists may find themselves faced with the dilemma of whether to change their treatment procedures to incorporate lasers or continue with traditional nonsurgical therapies. Evidence-based dental hygiene care incorporates emerging scientific evidence, along with clinician expertise and patient preferences in the decision-making process for patient care. Given this, these 2 studies provide no substantial evidence that the Er:YAG laser, equipped with a calculus detection system, is more effective clinically than hand scaling or sonic/ultrasonic instrumentation. In fact, these findings provide continued support that nonsurgical periodontal intervention may impact microbiological and clinical parameters over the short term, but that the effects then diminish over a 4 to 6 month period. The equivocal findings regarding patient comfort are likely attributable to use of local anesthetic in the one study versus not in the other study. In order to perform maximally effective subgingival instrumentation, the current standard is to use local anesthetic for patient comfort and clinician effectiveness. In situations where local anesthetic may not be practical, laser may provide an acceptable alternative; however, the smell associated with laser use was rated as undesirable in the

Derdilopoulou et al study, and should be considered by clinicians as well. Collectively, results from these 2 recent randomized clinical trials suggest that the Er:YAG laser is not superior to hand, sonic, or ultrasonic instrumentation at 4 and 6 months following treatment. Future studies should be conducted to examine whether there is a differential effect of these interventions applied repeatedly in a supportive therapy manner over longer periods of time. Only then can clinicians make determinations about the clinical utility of various nonsurgical periodontal treatments.

Therefore, the following recommendations can be made based on the findings in these 2 studies:

- "Hand, ultrasonic, sonic, and Er:YAG periodontal instrumentation produce an initial reduction of periodontal pathogens, but the effect is short lived.
- "The Er:YAG laser is not superior at reducing periodontal pathogens or improving clinical parameters compared to ultrasonic, sonic, or hand instrumentation.
- The acceptability of lasers in a periodontal population is equivocal when compared to ultrasonic instrumentation.

Summary

Dental hygiene clinicians must continually revise and assess their decisions about providing appropriate and effective care as new evidence is generated. In this technological world, clinicians are often faced with claims that, at face value, sound exciting and promise "best outcomes" without evidence to support such claims. In addition, dentist employers may expect dental hygienists to begin incorporating laser therapy into nonsurgical periodontal treatment for patients as one means to offset their financial investment in the device. These studies provide early evidence that the Er:YAG laser therapy may provide similar, but not superior, outcomes in nonsurgical periodontal treatment. It is important to note that both studies used the Er:YAG laser at an energy level of 160mJ/pulse with a pulse frequency of 10Hz, with water irrigation. At higher energy levels, in-vitro use of the Er:YAG has been shown to cause root surface damage consisting of surface charring and crater-like defects. Clinicians interested in using laser for periodontal therapy need to be fully cognizant of the manufacturers recommendations for energy settings and directions for use.

As technologies advance, the same standards for evidence-based clinical decision making should be applied to new therapies and devices. Randomized clinical trials still provide the "best evidence" for single studies, assuming that these studies conform to quality standards by using random assignment, examiners who are calibrated and blind to treatment group assignment, control treatment(s), appropriate statistical analyses, and control for various confounders. The current 2 randomized clinical trials conform to these standards of quality, and, not surprisingly, obtained similar findings. Collectively, the results from these 2 studies suggest no difference between traditional nonsurgical interventions and laser therapy with regard to clinical/microbial outcomes. Clinicians should be wary of claims that are not independently supported by empirical findings.