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Subjective intensity of pain during supportive periodontal treatment using a sonic scaler or an Er:YAG laser

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Abstract

Objective: To assess the subjective intensities of pain during supportive periodontal treatment using a sonic scaler or an Er:YAG laser.

Material and Methods: Forty patients with two residual periodontal pockets following conventional periodontal therapy were treated using a sonic scaler and an Er:YAG laser in a split-mouth design. A visual analogue scale was used for pain assessment directly after each treatment procedure. Additionally, pain was recorded during the treatment of 11 patients at intervals of 0.5 s using an inter-modal intensity comparison.

Results: Pain assessment during treatment showed that laser treatment (median pain score: 0.71 U, maximum: 9.94 U, minimum: 0 U) caused less pain than the sonic device (median pain score: 2.17 U, maximum: 11.26 U, minimum: 0 U) ($p < 0.05$) with no difference in the treatment time ($p > 0.05$). These results could be confirmed by the visual analogue scale: pain scores assessed after laser treatment (median: 1 U, maximum: 7 U, minimum: 0 U) were lower than those after sonic instrumentation (median: 3.5 U, maximum: 7.5 U, minimum: 0 U) ($p < 0.05$).

Conclusions: Using an Er:YAG laser during supportive periodontal treatment, painful sensations can be reduced compared with sonic scaler instrumentation.

Key words: inter-modal intensity comparison; pain assessment; supportive periodontal treatment; ultrasonic instrumentation; visual analogue scale

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The primary goal of periodontal therapy regimens is infection control by removal of supra- and subgingival plaque and calculus and prevention of recolonization of periodontal pockets by pathogenic bacteria. The importance of a regular periodontal care has been shown in several studies (Axelsson & Lindhe 1981, Lindhe & Nyman 1984, Kaldahl et al. 1996). Thus, supportive periodontal care (SPC) must be regarded as an integral part of overall periodontal management (American Academy of Periodontology 2000, Cohen 2003) for preserving the clinical improvements gained by previous periodontal treatment procedures and to avoid further tissue destruction (Axelsson et al. 1991). The overall aims of SPC can be summarized as follows: (I) to prevent the recurrence and progression of periodontal disease in patients who have previously been treated for gingivitis, periodontitis or peri-implantitis; (II) to prevent or reduce the incidence of tooth loss by monitoring the dentition and any prosthetic replacements of the natural teeth; and (III) to increase the probability of locating and treating, in a timely manner, other diseases and conditions found in the oral cavity (Committee on Research, Science and Technology of the American Academy of Periodontology 1998). At present, there are several therapy regimens such as power-driven, hand or laser instrumentation to achieve these aims. However, all these regimens should be well accepted by the patients to enhance the patient's compliance and possibly improve the prognosis of SPC. The compliance with dental treatment procedures is affected by many factors, including self-destructive behaviour, fear, economic factors, health beliefs, stressful events in their lives and perceived dentist indifference

Conflict of interest and source of funding statement

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(Wilson 1998). Thus, the ability to deliver dental care with a minimum of patient discomfort should be an essential part of a clinician's skills to avoid a decline of compliance.

The intensities of painful sensations during supra- and subgingival periodontal treatment can be affected using different power-driven devices and scaler tip styles (Braun et al. 2003, 2007, Hoffman et al. 2005, Walmsley et al. 2008). Especially, a linear oscillating device is well tolerated by patients and can be used without local anaesthesia (Guentsch & Preshaw 2008). Comparing ultrasonic and hand instrumentation in periodontally involved teeth, it could be shown that the linear oscillating device caused less painful sensations than hand instruments (Braun et al. 2003). In a recent consensus report on innovations in non-surgical periodontal therapy, it was stated that there is a need for studies to address patient-centred outcomes such as treatment discomfort, etc. (Sanz & Teughels 2008).

Laser treatment procedures are expected to serve as an alternative or an adjunctive treatment to conventional, mechanical periodontal therapy. At present, there is insufficient evidence to support the clinical application of either CO_2, Nd:YAG, Nd:YAP or different diode laser wavelengths in non-surgical periodontal treatment. However, Er:YAG laser application compared with mechanical debridement resulted in similar clinical outcomes, both in the short and in the long term (up to 24 months), in patients with chronic periodontitis (Schwarz et al. 2008). It was concluded that the Er:YAG laser might be an appropriate treatment procedure for the non-surgical and supportive therapy of chronic periodontitis. Evaluating pain scores with a visual analogue scale (VAS) immediately after Er:YAG laser treatment in SPC, the degree of treatment discomfort scored significantly lower for the laser than for the ultrasonic treatment modality (Tomasi et al. 2006).

At present, studies conducted so far have not evaluated subjective pain intensities caused by sonic treatment during SPC. Moreover, there are no data on sonic treatment compared with the use of an Er:YAG laser. Thus, the aim of the study was to compare subjective pain sensations during subgingival root surface instrumentation using a sonic and a laser device, testing the hypothesis of Er:YAG laser treatment causing less pain sensations during subgingival SPC.

Material and Methods

Forty patients with chronic periodontitis (19 female, 21 male, mean age: 55.3 ± 10.0 years, all non-smokers), each presenting with two residual periodontal pockets at two teeth [probing depth ≥ 5 mm and bleeding on probing (BOP) (+) or probing depth ≥ 6 mm and BOP(+/−)] after completed conventional periodontal therapy with no sub- or supragingival calculus clinically observable, were treated using a sonic scaler (Sonicflex 3000 L, KaVo, Biberach, Germany) (Fig. 1) and an Er:YAG laser (KEY Laser 3, KaVo) in a split-mouth multicentre study design. The participating centres were (I) Department of Periodontology, Operative and Preventive Dentistry, University Dental Clinic Bonn and (II) Department of Operative Dentistry and Periodontology, University Dental Clinic Freiburg. The sonic device was turned to power setting ''1'' with the slim-line shaped periodontal insert No. 60. According to the manufacturer, the maximum amplitude of oscillation was 120 μm at 6.5 kHz for the level ''1'' power setting (DIN EN ISO 1506:2000-07). The scaler tip shows a predominantly ellipsoid oscillation pattern. The Er:YAG laser (KEY Laser 3) was operated with the 2061 handpiece and the 1.65 light wedge with an energy setting of 120 mJ at the laser panel, representing an effective energy of 86 mJ at the working tip. The pulse repetition rate was 10 Hz with a continuous water flow and the fluorescence feedback system switched off, as otherwise the laser would only have been activated if calculus was detected.

The endpoint of treatment was time-dependent. As the patients presented after complete periodontal debridement, the teeth under study had clinically judged clean root surfaces. Therefore, the aim of the therapy was to remove the subgingival biofilm. The treatment time was set to 20 s per diseased root surface to achieve biofilm removal. The whole circumference of the tooth was divided into six root surfaces, resulting in a maximum treatment time of 2 min. per tooth.

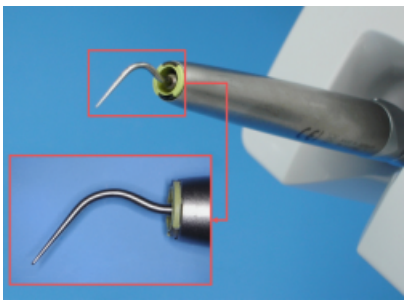

Fig. 1. Slim-line-styled sonic scaler tip used in the study. The device was operated with power setting ''1'', resulting in a maximum oscillation amplitude of 120 μm at 6.5 kHz.

The sequence of the different treatment devices was randomly assigned using computer-generated random number table: considering the tooth sequence upper right last molar to upper left last molar and lower left last molar to lower right last molar, the first diseased tooth in this sequence was assigned to the firstly randomly determined treatment device, leaving the remaining tooth to be treated with the other device. Both sonic and laser therapy in one patient were performed by the same operator, allowing an intra-experimental comparison of the values. Test and control sites were treated at the same visit.

With respect to the clinical effectiveness of the two investigated treatments at baseline and 3 months after treatment, the BOP frequency was evaluated by a blinded investigator who was not involved in the treatment of the patients. BOP was assessed for the two teeth under study separately by gentle probing of the gingival sulcus with a PCP UNC 15 periodontal probe. Bleeding points were assessed 30 s after probing.

The study was performed without using any local anaesthetics, as no participant asked for it. However, every participant was aware that local anaesthetics would have been provided in the case of unbearable pain or at the subject's option.

In all forty patients, the subjective intensities of pain were assessed with a VAS ranging from 0, representing no pain or discomfort, to 10, representing maximum pain and discomfort, evaluating the overall pain perception for the treatment. Additionally, in eleven patients, pain was recorded during the treatment procedure at intervals of 0.5 s using an inter-modal intensity comparison according to a previously published study design (Braun et al. 2003, 2007): the patient held the bulb of a manometer (Speidel and Keller, Jungingen, Germany) in his left hand with the output monitored by a computer (Fig. 2). The patient was asked to set the pressure of his hand in proportion to the perceived intensities of pain. Thus, it was possible

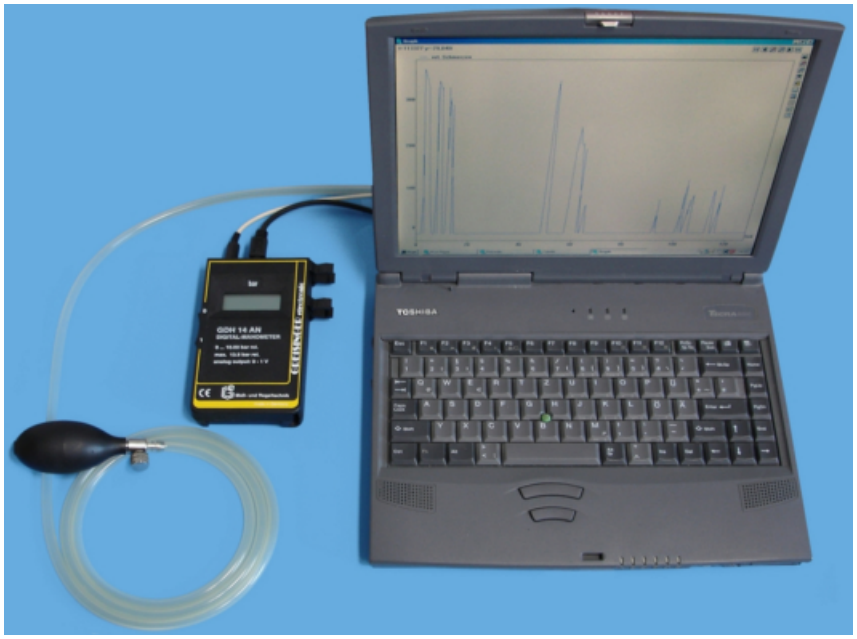

Fig. 2. PC-based device to record pain intensities during the treatment procedure at intervals of 0.5 s using an inter-modal intensity comparison.

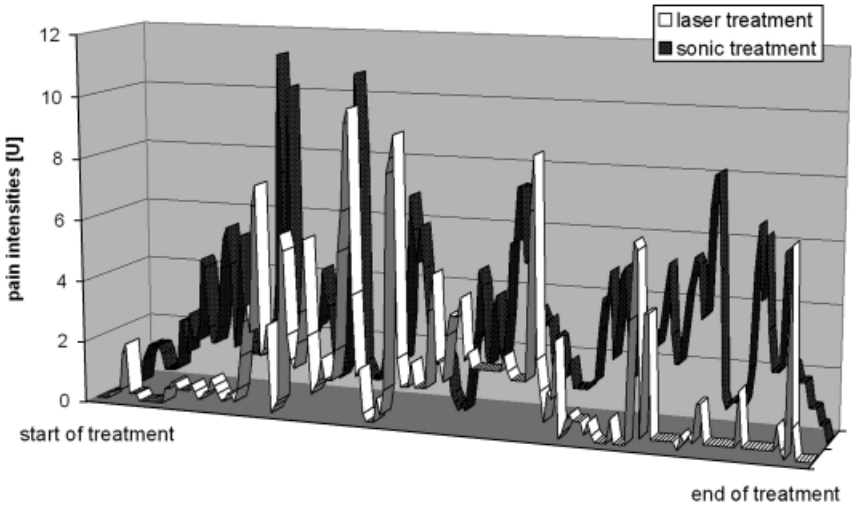

Fig. 4. Pain scores during laser and sonic treatment. Pain values (U) show the mean values of inter-modal intensity comparisons for 11 patients under study. Pain peaks could be observed both in the laser and in the ultrasonic group, reaching comparable intensity levels.

to monitor each single painful perception peak during the treatment interval. Additionally, treatment time was recorded to assess differences with respect to the treatment device used.

All patients had been informed about the study and had given their informed consent. The study was conducted in full accordance with the declared ethical principles (World Medical Association Declaration of Helsinki, version VI, 2002) and had been approved by the local Ethic's Committee (reference number: 198/05).

A power analysis was performed before the study. Therefore, the effect size was set to 0.8 according to Cohen (1988). For an α-error of 0.05 and a power of 0.8, a sample size of 40 subjects was calculated. For statistical analysis, normal distribution of the values was assessed using the Shapiro–Wilk test. As not all data were normally distributed, values for pain perception and the BOP index at baseline and after 3 months were analysed using a non-parametric test (Wilcoxon). The Mann–Whitney test was used to evaluate differences between

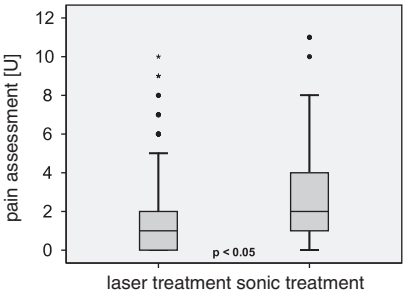

Fig. 3. Pain assessment using the inter-modal intensity comparison in 11 patients for the two different treatment devices evaluated in the present study. Significantly lower pain scores were obtained for laser treatment ($p<0.05$). Box plots show the median, first and third quartiles, minimum and maximum values (whiskers). Outliers are marked as data points and asterisks.

BOP values in the two treatment groups. Evaluating the correlation between the two different methods for pain assessment, cross tabulation tables of the VAS readings and overall mean values of hand pressure over time and the respective Pearson's correlation coefficients were computed. Differences were considered as statistically signicant at $p<0.05$.

Results

In the present study, no participant ever asked for a local anaesthesia, although all subjects were told that local anaesthetics would have been provided in the case of unbearable pain or at the subject's option. Pain scores could be shown to be dependent on the treatment device used. The inter-modal intensity comparison during treatment showed that the Er:YAG laser treatment (median pain score: 0.71 U, maximum: 9.94 U, minimum: 0 U) caused less pain than the conventional ultrasonic scaler (median pain score: 2.17 U, maximum: 11.26 U, minimum 0 U) ($p<0.05$) (Fig. 3). Assessing the occurrence of pain sensations over time, it could be demonstrated that pain did not occur constantly (Fig. 4). Subjective pain peaks could be observed both in the laser and in the ultrasonic group, reaching comparable intensity levels. These results could be confirmed by VAS measurements after therapy: treatment with the laser device (median pain score: 1 U, maximum: 7 U, min: 0 U) caused statistically significantly less pain than power-driven instrumentation (median pain score: 3.5 U, maximum: 7.5 U,

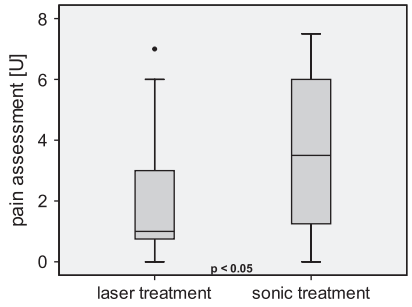

Fig. 5. Pain assessment using the visual analogue scale in 40 patients for the two different treatment devices evaluated in the present study. Significantly lower pain scores were obtained after laser treatment ($p<0.05$). Box plots show the median, first and third quartiles, minimum and maximum values (whiskers). Outliers are marked as data points and asterisks.

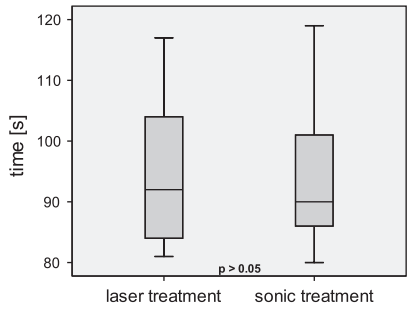

Fig. 6. Treatment time with the laser and sonic device for the 11 patients, with pain assessment by inter-modal intensity comparison. Time did not differ in the two groups ($p>0.05$). Box plots show the median, first and third quartiles, minimum and maximum values (whiskers). Outliers are marked as data points and asterisks.

minimum: 0 U) ($p<0.05$) (Fig. 5). Evaluating the readings of the two different methods for pain assessment, a significant positive correlation could be found between the VAS and the overall mean pain values of hand pressure over time for both the laser (Pearson's *r*: 0.856, $p<0.05$) and the sonic treatment (Pearson's *r*: 0.665, $p<0.05$). The treatment time did not differ in the laser (median time: 92 s, maximum: 117 s, min: 81 s) and the ultrasonic group (median time: 90 s, maximum: 119 s, min: 80 s) ($p<0.05$) (Fig. 6).

Values for the BOP frequency did not show statistically significant differences between the laser (86.1%) and the sonic group (83.3%) ($p>0.05$). After 3 months, the frequency values decreased significantly within both groups ($p<0.05$), with no difference between the laser (50.0%) and the sonic (50.0%) treatment ($p>0.05$).

Discussion

Subjective pain intensities during supportive periodontal treatment with the Er:YAG laser and the sonic device differed statistically significantly: patients perceived less pain during laser instrumentation of the root surface. Regarding the treatment time for the devices under study, there was no difference in the laser and the sonic group. Thus, the number of periodontally involved root surfaces should have been equally distributed in the two groups, as the treatment time was set to 20 s per surface.

In the present study, painful sensations were assessed during and after two different treatment procedures. As inter- and intra-individual differences in pain sensation could not be excluded, the evaluation was designed as a split-mouth study. Therefore, inter-individual differences in pain perception affected the two treatment groups in the same way. As a consequence, the statistical analysis was performed using a paired non-parametric test, considering the possibility of inter-individual differences in pain perception. With respect to intra-individual pain sensations, the sequence of the different treatment devices was randomly assigned using a computer-generated random number table.

Comparing a sonic and an ultrasonic scaler regarding painful sensations by means of a VAS during prophylaxis treatment, no difference could be observed between these two treatment modalities (Kocher et al. 2005b). Focusing on pain associated with periodontal maintenance therapy, no difference could be demonstrated, comparing the piezoelectric Vector™ device and a conventional ultrasonic device at a reduced power setting (Kocher et al. 2005a). The authors used a VAS to evaluate subjective pain perception in this study. However, this kind of pain assessment allows only a retrospective description of previously perceived painful sensations, so that short high peaks of pain may be recorded imprecisely (Huskisson 1983, Tammaro et al. 2000). Therefore, in the present study, pain was recorded along with the SPC treatment procedure using an inter-modal intensity comparison to increase the precision of pain assessment. Thus, it was possible to correlate every single painful sensation to the exact treatment time (Braun et al. 2003). Consequently, this procedure has to be considered more precise in pain assessment, as a VAS does not include time as a variable. Evaluating not a whole treatment procedure but only a single possibly painful sensation like periodontal probing with different-sized instruments (Hassan et al. 2005), the use of a VAS appears to be appropriate for pain assessment as the probing procedure represents a temporally defined pain sensation. In the present study, pain should be evaluated during the whole SPC treatment procedure. As a consequence, values of the well-established VAS were amended by the inter-modal intensity comparison with hand pressure. A manometer for hand pressure assessment is a device described previously for inter-modal intensity comparisons (Stevens 1970, Braun et al. 2003). It was possible to set the pressure of a subject's hand in proportion to the intensity of light (Stevens 1970). In further studies, the intensities of heat, weight, cold, vibration and sound were evaluated using a manometer (Stevens 1975). A recent study evaluated pain intensities by an inter-modal intensity comparison with a manometer during supragingival calculus removal at the mandibular front teeth. Using slim-line-styled ultrasonic scaler tips, painful sensations were found to be reduced compared with conventional ultrasonic devices (Braun et al. 2007).

Another inter-modal matching device is the so-called ''finger span'': two metal arms were taped to the thumb and index finger of the subject. The distance of these two arms was measured using a potentiometer and set in relation to the subjective intensities of pain (Franzén & Berkley 1975).

The recording of evoked potentials is another possibility for detecting tooth-related painful sensations in humans (Braun et al. 2000). In the present study, this method was not applicable as both the laser irradiation and the sonic vibration do not represent an exact temporally defined and reproducible peripheral stimulus, so that characteristic dental potentials are not distinguishable from the spontaneous activity of the cortex. Er:YAG laser irradiation for periodontal debridement showed only a minimal root cementum removal compared with conventional scaling and root

planing, with 73.2% of the root dentine being completely denuded from the cementum (Eberhard et al. 2003). Particularly during supportive periodontal treatment, the primary goal is not calculus removal, as the amount of mineralized deposits on the root surface should have been removed previously. Thus, SPC aims to remove a periopathogenic biofilm without affecting sound hard tissues of the root surface. It could be shown that removal of hard tissues can be decreased using an ultrasonic device compared with conventional hand instrumentation of the root surface (Braun et al. 2005), and tooth surfaces are debrided as thoroughly as with conventional instruments (Braun et al. 2006), but it could also be demonstrated that the aggressiveness of magnetostrictive and piezoelectric ultrasonic devices to root substance is significantly influenced by the scaler tip designs (Jepsen et al. 2004). A recently published study could show that the microbiological effects of hand instruments, Er:YAG laser, sonic and ultrasonic scalers in patients with chronic periodontitis resulted in a comparable reduction of the evaluated periodontal pathogens, and bacterial increase was only partially different 6 months post-operatively (Derdilopoulou et al. 2007). As a consequence, the use of an Er:YAG laser and a sonic device can also be suggested for SPC treatment procedures. Additionally, the fibroblast attachment to periodontally diseased root surfaces treated with an Er:YAG laser device is increased compared with ultrasonic root instrumentation (Crespi et al. 2006).

In the present study, the authors wanted to focus on pain perception. Periodontal treatment procedures are usually correlated with painful sensations. However, only a few studies deal with this important aspect of periodontology or present only minor information, not attracting an appropriate amount of attention. On the other hand, the procedures used for periodontal supportive treatment have been evaluated for this purpose before. Sonic or ultrasonic scalers seem to be similarly effective as manual debridement regarding clinical attachment gain, probing pocket depth reduction and BOP reduction (Tunkel et al. 2002, Suvan 2005). It could be demonstrated that Er:YAG laser treatment in SPC showed similar effects on clinical and microbiological parameters as ultrasonic instrumentation (Tomasi et al. 2006). The only difference was less treatment discomfort in the laser group. These results are in accordance with those of the present study. It could also be demonstrated that laser treatment showed less painful sensations, with similar results for the reduction of BOP.

The present study indicates that the use of an Er:YAG laser during supportive periodontal treatment reduces painful sensations compared with sonic scaler instrumentation. Considering the overall aim to deliver dental care with minimum patient discomfort, it thus might be possible to increase the patient's compliance during periodontal supportive therapy.

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Clinical Relevance

Scientific rationale of the study: Particularly with regard to fearful and sensitive patients, a treatment device inducing only minor painful sensations would be desirable, in order to enhance the patient's compliance and possibly improve the prognosis of periodontal care. So far, pain during supportive periodontal treatment is poorly evaluated.
Principal findings: By using an Er:YAG laser device for instrumentation of residual periodontal pockets during supportive periodontal treatment, painful sensations can be reduced compared with sonic scaler treatment.
Practical implications: Clinicians can deliver pain-reduced SPC with an Er:YAG laser and thereby possibly improve compliance.