J Clin Periodontol 2007; 34: 668–672 doi: 10.1111/j.1600-051X.2007.01100.x

Journal of Clinical Periodontology

Subjective intensity of pain during ultrasonic supragingival calculus removal

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Braun A, Jepsen S, Krause F. Subjective intensity of pain during ultrasonic supragingival calculus removal. J Clin Periodontol 2007; 34: 668–672. doi: 10.1111/j.1600-051X.2007.01100.x.

Abstract

Objective: To assess subjective intensities of pain during supragingival calculus removal employing ultrasonic scaler tips of two different shapes.

Material and Methods: Twenty patients were treated using a piezoelectric ultrasonic device (Sirosonic L) and two different scaler tips representing a conventional (Instrument No. 3) and a slim-line style (Perio Pro Line Instrument SI-11) in a split-mouth design. Pain was recorded during calculus removal at intervals of 0.5 s employing an inter-modal intensity comparison. Additionally, a visual analogue scale was used for evaluation directly after the treatment procedure. Treatment time was recorded to assess the efficiency of calculus removal.

Results: Pain assessment during treatment showed that the slim-line scaler tip (median pain score: 1.4 [U], maximum: 3.5 [U], minimum: 0 [U]) caused less pain than the conventional device (median pain score: 7.8 [U], maximum: 14.7 [U], minimum: 0 [U]) ($p < 0.05$). These results could be confirmed by the visual analogue scale. Treatment with the slim-line tip took significantly longer than treatment with the conventional tip ($p < 0.05$).

Conclusions: Using slim-line-styled ultrasonic scaler tips for supragingival calculus removal, painful sensations can be reduced compared with conventional ultrasonic devices. Thus, it might be possible to increase the patient's compliance during dental treatment with oscillating instruments.

Key words: calculus removal; inter-modal intensity comparison; pain assessment; ultrasonic instrumentation; visual analogue scale

Accepted for publication 4 April 2007

Reducing supra and subgingival plaque and calculus as well as preventing recolonization of periodontal pockets by pathogenic bacteria are fundamental aspects of periodontal therapy (Westfelt 1996). Therefore, dental plaque, an adherent, bacterial biofilm that forms on soft and hard tissues (Bernimoulin 2003) and calcified deposits should be removed from the tooth surface. Calculus can be removed employing hand scalers, ultrasonic instruments, air-powder abrasive scalers, diamond burs and lasers. A beneficial effect of ultrasonic instrumentation in creating a smooth surface without extensive removal of hard tissues could be demonstrated (Jacobson et al. 1994). Moreover, adjustments in working parameters, shapes and sizes shall allow the adaption of an ultrasonic scaler's efficacy to various clinical needs (Flemmig et al. 1997, 1998b, Braun et al. 2005a, b) and may influence efficacy and aggressiveness of the respective device (Jepsen et al. 2004). Additional cavitational and acoustic microstreaming patterns (Walmsley et al. 1990, Khambay & Walmsley 1999) are supposed to facilitate instrumentation of less-accessible areas and reduce the proportion of Gram-negative bacteria (Leon &Vogel 1987). Dental plaque formation in a healthy subject first occurs supragingivally, which then often progresses subgingivally (Bernimoulin 2003). Leaving this biofilm on the tooth surface in case of inadequate oral hygiene, plaque can mineralize and form calculus deposits. Thus, especially during periodontal maintenance care or after calculus formation on not periodontally involved teeth, the primary need of dental therapy might be supragingival calculus removal. Moreover, carefully performed supragingival cleaning procedures can change the composition and the quantity of subgingival microbiota with a possi-

Conflict of interest and source of funding statement

The authors declare that they have no conflict of interests.

The study was self-funded by the authors and their institution. Sirona Dental systems are acknowledged for providing the ultrasonic insert tips.

ble decrease in the number of periodontopathogens (Dahlén et al. 1992, Hellström et al. 1996). However, exclusive supragingival plaque control fails to prevent further periodontal tissue destruction in subjects with advanced periodontal disease (Westfelt et al. 1998).

Patient's compliance with dental treatment procedures is affected by many reasons, including self-destructive behaviour, fear, economic factors, health beliefs, stressful events in their lives and perceived dentist indifference (Wilson 1998). Supragingival calculus removal procedures are reported to cause painful sensations in the patient (Kocher et al. 2005b). 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. Recent research could demonstrate the possibility to affect these sensations employing different ultrasonic devices, scaler tip styles or treatment procedures for subgingival treatment (Braun et al. 2003, Hoffman et al. 2005). Particularly with regard to fearful and sensitive patients, a device inducing only minor painful sensations during supragingival treatment procedures would be desirable, thus enhancing the patient's compliance and possibly improving the prognosis of periodontal care.

Testing the hypothesis of pain being correlated with the shape of different scaler tips of the same ultrasonic device, the aim of this study was to compare subjective pain sensations during supragingival calculus removal. Both the patient's current sensations during the whole treatment procedure and a summarized judgment after the treatment were evaluated. The patient's acceptance of the different modifications of the ultrasonic device was classied, as it strongly correlates with their painfulness.

Material and Methods

Twenty patients (11 females, nine males, mean age: 43.6 ± 11.5 years), each of whom presented with supragingival calculus on the respective mandibular front teeth and with comparable periodontal pocket depths of 4 mm or less, were treated using a piezoelectric ultrasonic handpiece (Sirosonic L, Sirona, Bensheim, Germany) and two different scaler tips representing a conventional (Instrument No. 3, Sirona, Benshelm, Germany) and a slim-line style (Perio Pro Line Instrument SI-11, Sirona) (Fig. 1). According to the manufacturer, the maximum amplitude of oscillation was 160 μm at 29.4 kHz and 120 μm at 30.5 kHz, respectively, for the 100% power setting (DIN EN ISO 22374). Both scaler tips showed a predominantly linear oscillation pattern and were operated at the 100% setting of the ultrasonic device. The same diameter of 0.6 mm could be measured at a distance of 1 mm to the end of the inserts. Owing to different conicities, at a distance of 5 mm the diameter of the slim-line-shaped tip (0.7 mm) was smaller than the value for the conventional device (1.2 mm). Patients received professional dental care and tooth cleaning procedures regularly but no surgical periodontal treatment before. All treatment procedures were performed by one operator. Using a split-mouth study design, the sequence of the different treatments was randomly assigned by use of a computer-generated random number table: either the lower right or left front teeth were treated with one type of scaler, leaving the remaining front teeth to be treated with the other scaler tip. 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: 134/06). Pain was recorded during calculus removal at intervals of 0.5 s employing an intermodal intensity comparison according to a previously published study design (Braun et al. 2003): the patient held the bulb of a manometer (Speidel and Keller, Jungingen, Germany) in his left hand with the output monitored by a computer. The patient was asked to set the pressure of his hand in proportion to the perceived intensities of pain. Additionally, after the treatment the subjective intensities of pain were assessed with a visual analogue scale (VAS) ranging from 0, representing no pain or discomfort, to 10, representing maximum pain and discomfort. After each treatment, a new paper-bow with the printed interval scale was given to the patient, so that he could not be influenced by the previous results. Treatment time was recorded to assess the efficiency of calculus removal. The endpoint of treatment was a clinically judged clean tooth surface. The study design comprised only the removal of supragingival calculus. If subgingival calculus was detected during the treatment procedure, it was removed without pain assessment after supragingival cleaning of all front teeth.

For statistical analysis normal distribution of the values was assessed with the Shapiro–Wilk test. As not all data were normally distributed, values were analysed with a nonparametric test (Wilcoxon). Evaluating the correlation between the two different methods for pain assessment, cross tabulation tables of the VAS readings and both overall mean and median values of hand pressure over time and the respective Pearson' correlation coefficients were computed. Differences were considered as statistically signicant at $p < 0.05$.

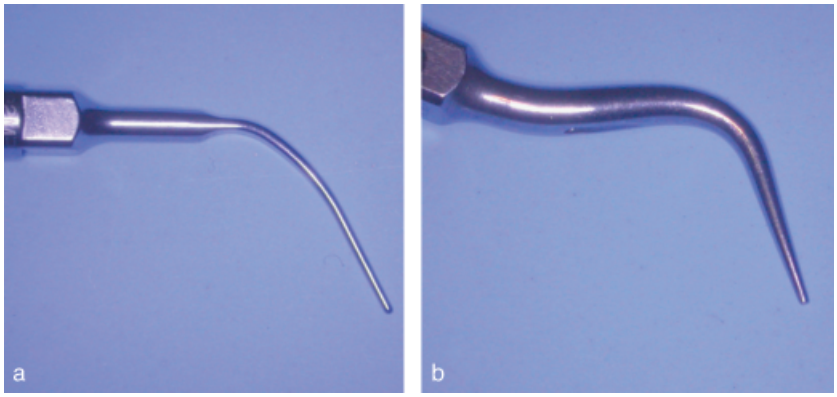

Fig. 1. Slim-line-styled (a) and conventional ultrasonic scaler tip (b) used in the study, both operated with the same handpiece and power settings.

Results

Pain scores could be shown to be dependent on the used ultrasonic scaler tips. The inter-modal intensity comparison during treatment showed that the

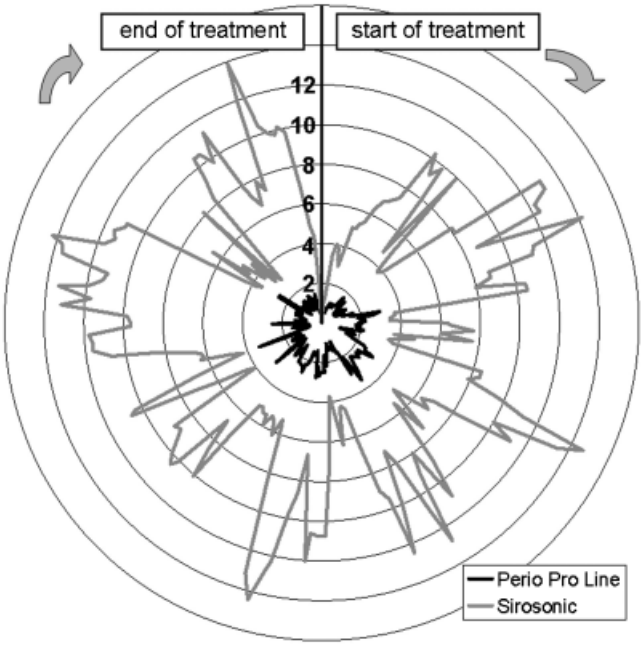

Fig. 2. Pain scores during ultrasonic treatment with the Sirosonic tip and the slim-line styled Perio Pro Line instrument. Pain values [U] show mean values of inter-modal intensity comparisons for the 20 patients under study. Start of treatment at 12 o'clock position, running clockwise to the end. Lowest pain scores during calculus removal with the Perio Pro Line tip.

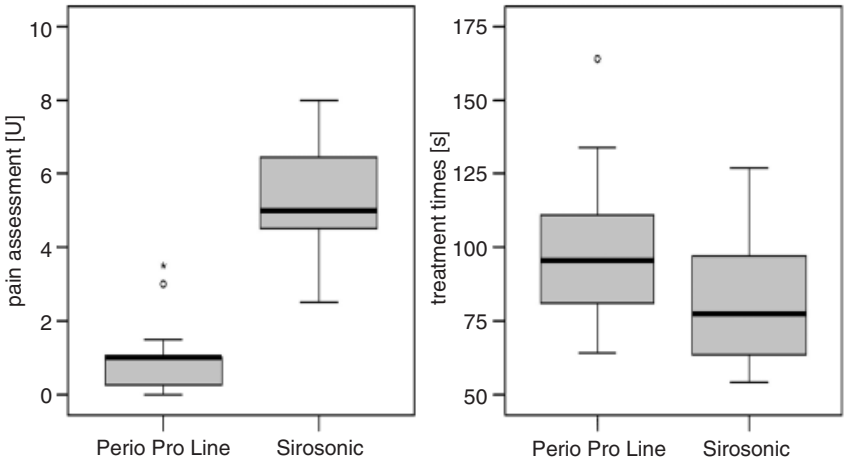

Fig. 3. Pain assessment employing the visual analogue scale and treatment time for the two different ultrasonic tips evaluated in the present study. Significantly lower pain scores after treatment with the slim-line-styled instrument ($p < 0.05$) but shorter treatment time for calculus removal with the conventional device ($p < 0.05$). Box plots show median, first and third quartiles, minimum and maximum values (whiskers). Outliers are marked as data points and asterisks.

slim-line-styled scaler tip (median pain score: 1.4 [U], maximum: 3.5 [U], minimum: 0 [U]) caused less pain than the conventional ultrasonic scaler (median pain score: 7.8 [U], maximum: 14.7 [U], minimum: 0 [U]) ($p < 0.05$). Assessing the occurrence of pain sensations over time, it could be demonstrated that pain did not occur constantly but treatment with the slim-line-styled scaler tip was never assessed to be as painful as the treatment with the conventional ultrasonic tip (Fig. 2). These results could be confirmed by VAS measurements after therapy (Fig. 3). Evaluating the readings of the two different methods for pain assessment, no correlation could be found between the VAS and the overall mean and median pain values of hand pressure over time ($p > 0.05$). Treatment with the slim-line-styled scaler (median: 95.5 s, maximum: 164 s, minimum: 64 s) took significantly longer time than with the conventional tip (median: 77.5 s, maximum: 127 s, minimum: 54 s) ($p < 0.05$).

Discussion

Regarding scores of both the VAS and the inter-modal intensity comparison during the treatment procedure, there was a significant difference in pain sensations between the two evaluated scaler tips. This difference cannot be explained by different periodontal conditions as all included teeth had comparable periodontal pocket depths, allowing an intra-experimental split-mouth comparison. Another study compared a sonic and an ultrasonic scaler regarding pain during prophylaxis treatment (Kocher et al. 2005b). By means of a VAS, no difference could be observed between these two treatment devices. Assessing pain associated with periodontal maintenance therapy, no difference could be demonstrated, comparing the Vector™ device (Duerr Dental, Bietigheim-Bissingen, Germany) and a conventional ultrasonic device at a reduced power setting (Kocher et al. 2005a). Once again, only a VAS was used to assess pain perception in this study. This scale allows only a retrospective assessment of previous painful sensations. In contrast, in the present study it was possible to record pain simultaneously with the treatment procedure and thus extend the precision of pain assessment. Recording intensities of pain during the whole treatment procedure employing a manometer gives the opportunity to assess any pain sensations correlated with the exact treatment time (Braun et al. 2003). The more common method of evaluating pain scores with a VAS assesses painful sensations only retrospectively, so that possible high peaks of pain may be recorded imprecisely (Huskisson 1983, Tammaro et al. 2000). Thus, an inter-modal intensity comparison, measuring painful sensations at intervals of 0.5 s, is not limited to one recapitulating VAS value recorded after the treatment procedure but gives time-dependent readings. As a consequence, an inter-modal intensity comparison can be considered more precise concerning pain assessment, as a VAS does not include time as a variable. The different qualities of the two methods are reflected in the

finding of no correlation between the respective outcomes. Unfortunately, there are no further studies available comparing the outcomes of a VAS to an inter-modal intensity comparison by hand pressure. However, evaluating only short-time pain sensations, e.g. correlated with periodontal probing (Hassan et al. 2005), the use of a VAS appears to be appropriate for pain recording as the probing procedure comprised a temporally defined pain sensation. Another possibility for detecting tooth-related painful sensations in humans is the recording of evoked potentials (Braun et al. 2000). In the present study, this method was not applicable as the ultrasonic vibration does 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. Thus, VASs and inter-modal intensity comparisons with a manometer were suitable to estimate the pain intensities in the present study. A manometer like the one used in the present study is a tool previously described for inter-modal intensity comparisons (Stevens 1970, Braun et al. 2003). Stevens used a manometer 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 comparable inter-modal matching device is the so-called ''finger span'' (Franzén & Berkley 1975): two metal arms were taped to the thumb and index nger of the subject. The distance of these two arms was measured with a potentiometer and set in relation to the subjective intensities of pain.

In the present study, supragingival calculus was assessed only at the mandibular front teeth. The reason for limiting to these teeth was that calculus formation is most commonly seen on the lingual aspects of the lower incisors and canines and on the buccal aspects of the upper first and second molars. These sites of predilection coincide with the openings of the major salivary glands (Addy & Koltai 1994). The amount of individual calculus accumulation was not assessed before treatment as in the present study both evaluated treatment procedures were used in a split-mouth design, allowing an intra-experimental comparison of the two ultrasonic scaler tips under study. In the present study, all ultrasonic scalers were used with a tip angulation close to 0°. Investigating working parameters of a sonic and piezoelectric ultrasonic scaler on root substance removal, it could be shown that this angulation might prevent severe root damage (Flemmig et al. 1998a, b, 1997). Instruments were always used with the same power settings and instrumentation of all teeth was undertaken by one investigator, allowing an inter-instrumentation comparison within the experimental set-up. Regarding the oscillation at the used power setting, there was no major difference in the frequency of the used tips but the maximum amplitude of 160 μm for the conventional scaler and 120 μm for the slim-line-styled tip could have influenced pain perception. According to the manufacturer, this difference in amplitude is due to the design of the scaler tips. The occurrence of different amplitudes may therefore explain the higher efficiency of the conventional ultrasonic tip: treatment with the slim-line-styled insert took significantly longer than calculus removal with the conventional tip. This result is in accordance with previous studies evaluating subgingival calculus removal employing various insert tips of the piezoelectric ultrasonic Vector™ device (Braun et al. 2005a, 2006).

The present study indicates that the use of slim-line-styled ultrasonic scaler tips for supragingival calculus removal may result in reducing pain sensations compared with conventional ultrasonic devices. Considering the overall aim to deliver dental care with a minimum of patient discomfort, it thus might be possible to increase the patient's compliance during dental treatment with oscillating instruments.

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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, thus enhancing the patient's compliance and possibly improving the prognosis of periodontal care. Pain assessment during supragingival calculus removal is poorly evaluated and might lead to reducing patient discomfort.

Principal findings: Using slim-line-styled ultrasonic scaler tips for supragingival calculus removal, painful sensations can be reduced but treatment is more time consuming.

Practical implications: Clinicians can perform pain-reduced supragingival debridement procedures with slim-line-styled ultrasonic tips but have to expect a longer treatment time than with conventional devices.