

SONIC AND ULTRASONIC SCALERS IN A CLINICAL COMPARISON

A study in non-instructed patients with gingivitis or slight adult periodontitis

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Summary

In the present study, the Cavitron® 2002 ultrasonic scaler was compared with the Titan-S® air scaler in 20 subjects with gingivitis or slight periodontitis, whereby the majority of the patients suffered from gingivitis. A split mouth experimental design was used. However, patients did not receive any oral hygiene instructions during the study in order to allow the observation of the true effect of instrumentation. The outcome of a one-time treatment was assessed after 4, 14, 28, and 56 days. Gingival crevicular fluid (GCF), papilla bleeding index (PBI), plaque index (PI-I), probing depth (PD), and relative attachment level (AL) were measured. Both treatments resulted in a statistically significant decrease of clinical signs of inflammation (PBI: $p < 0.001$). Probing depths decreased ($p < 0.001$) and a small gain of attachment of $0.11 \text{ mm} \pm 0.05 \text{ mm}$ ($p < 0.001$) was observed. Following treatment, a statistically significant ($p < 0.001$) decrease in GCF and PI-I was observed between baseline and day 4. No statistically significant difference between the instruments' influences on the evaluated clinical parameters could be found. Thus it can be concluded indirectly that the Cavitron® 2002 and the Titan-S® are both useful instruments for scaling of tooth and root surfaces.

Schweiz Monatsschr Zahnmed 105: 165–170 (1995)

Key words:

Sonic scaler, ultrasonic scaler, gingivitis, periodontitis, scaling

Zur Veröffentlichung angenommen: 30.8.1994

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Introduction

Clinical studies have demonstrated the effectiveness of meticulous plaque and calculus removal from tooth crown and root surfaces in the treatment of gingivitis and adult periodontitis (LÖVDAL et al. 1961, LÖE et al. 1965, DONZE et al. 1973, HUGHES & CAFFESSE 1978, MORRISON et al. 1980, HILL et al. 1981, PIHLSTRÖM et al. 1981, CERCEK et al. 1983, WESTFELT et al. 1985, BADERSTEN et al. 1987, BUCHANAN & ROBERTSON 1987, RAMFJORD et al. 1987, HÄMMERLE et al. 1991, PEDRAZZOLI et al. 1991). Several short-term and long-term studies revealed better results for subgingival scaling and root planing without surgery than with surgery if probing depths were $< 7 \text{ mm}$ (PIHLSTRÖM et al. 1981, WESTFELT et al. 1985, BUCHANAN & ROBERTSON 1987, RAMFJORD et al. 1987). A thorough instrumentation using hand scalers and curettes is a cumbersome, time consuming and fatiguing task, regardless of the hand instrument used. For this reason, devices have been developed that make mechanical therapy easier. Ultrasonic scalers became available in the late 1950s (DRISKO 1993), but instrument tips that were too thick and not sufficiently cooled limited their use to supragingival plaque and calculus removal. More recently, such obstacles were overcome by the development of slender instrument tips with internal cooling. Ultrasonic devices employ the principle of magnetostriction, resulting in elliptical tip end motions of small amplitude at a frequency of 24 to 42 kHz (HOLBROOK & LOW 1991). It was confirmed in many investigations that ultrasonic scalers are equally effective as hand instruments for the instrumentation of root surfaces (METZGER & PLÜSS 1976, NISHIMINE & O'LEARY 1979, TORFASON et al. 1979, BADERSTEN et al. 1981, THORNTON & GARNICH 1982, BADERSTEN et al. 1984, BREININGER et al. 1987, OOSTERWAAL et al. 1987, COPULOS et al. 1993). In the late 1970s, sonic scalers were introduced as an alternative to ultrasonic scalers. It has been shown in many comparative in vitro and in vivo studies that sonic scalers are as effective as ultrasonic scalers or hand instruments (LIE & LEKNES 1985, GELLIN et al. 1986, LOOS et al. 1987, LAURELL & PETTERSON 1988, LAURELL 1990, BAEHNI et al. 1992). In these studies subjects were given oral hygiene instructions, usually at or before baseline examination. However, because of superimposition of the effects of oral hygiene instructions and instrumentation, it is difficult to single out from the published data the

effect of instrumentation. In order to allow the observation of the true effect of instrumentation, in the present study subjects did not receive oral hygiene instructions.

The goal of the present study was to evaluate and compare the influence on clinical parameters of an ultrasonic scaler (Cavitron® 2002, Dentalex Inc., Valley Forge, PA) and an air scaler (Titan-S®, Dentsply Inc., York, PA) in the treatment of subjects with established gingivitis or slight adult periodontitis, who were not instructed in oral hygiene.

Materials and methods

Twenty subjects—10 females and 10 males at the age of 21 to 61 years—participated in the study that was approved by the Basel University Institutional Review Board. The patients' average age was 32.5 ± 11 years (mean \pm SD). Subjects were informed about the experiment and gave informed consent. They were systemically healthy at the time of the study and did not take any medications. All presented clinically with moderate to severe gingivitis, or slight adult periodontitis. The majority (88%) of the pockets (sulci) exhibited probing depths up to 4 mm. There was no statistically significant difference ($p=0.430$) in the proportion of shallow (≤ 3 mm) to deep (>3 mm) pockets assigned for treatment to the two test instruments.

Instruments (Fig. 1): The Titan-S® air scaler (sonic scaler) is directly connected to the air supply of the high speed turbine of the dental unit. The compressed air causes a metal rod, which is located within the hand piece, to vibrate. As a result, the instrument oscillates at a frequency of 2.5 to 7 kHz and with an amplitude of 50 to 150 μm . The air pressure input was 2.5×10^5 Pa. In our study, a universal tip "56801" with internal water flow was used. There is no heat development at the instrument tip during treatment, thus the water flow rinses the instrument tip rather than cooling it. The Cavitron® 2002 ultrasonic scaler is a stand-alone device that is not part of the dental unit. The amplitude of the instrument tip motion is adjustable between 7 and 28 μm at a frequency of 25 kHz. The universal tip "TFI-1000" with internal cooling was used.

Sequence of Examinations, Procedures: At baseline (day 0), the subjects received a full-mouth examination including determination of gingival crevicular fluid, papilla bleeding index, Silness-Löe plaque index, probing depths, and estimation of relative attachment levels. The examinations were followed by the treatment using either one of the two test instruments as described below. Subsequent examinations were performed on days 4, 14, 28 and 56.

Gingival Crevicular Fluid (GCF) was measured on mesiobuccal, buccal and distobuccal sites. Collection of GCF was performed non-invasively at the gingival margin using filter paper strips with a notch 0.5 mm from the rounded end (RÜDIN et al. 1970). The notch allowed accurate and reproducible placement of the strip at the entrance of the crevice/pocket. Because contamination with saliva was difficult to control around molars, we restricted the evaluation of GCF data to incisors, canines and premolars. The GCF was determined after staining the strips with ninhydrin, using a magnifying glass (5 \times magnification). The precision of the measurement was 0.1 mm. GCF collection was carried out at each examination. **Gingivitis** was evaluated using the *papilla bleeding index (PBI)* as described by SAXER & MÜHLEMANN (1975). The PBI is a sensitive indicator of the presence and severity of the inflammation in the area of the gingival papilla (ENGELBERGER et al. 1983). Bleeding was induced

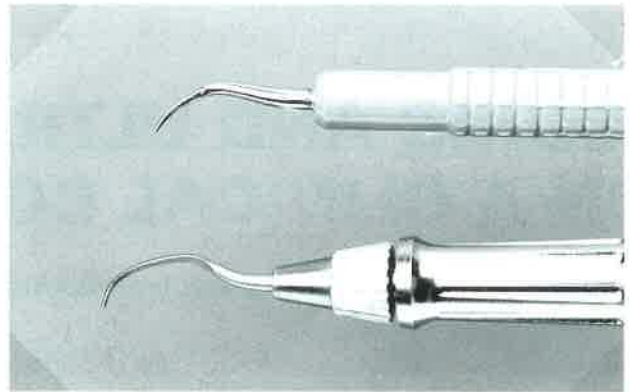


Fig. 1 Photograph of the Cavitron® 2002 ultrasonic scaler (above) and the Titan-S® sonic scaler (below).

by inserting the tip of a blunt periodontal probe (CP 12, A. Deppeler Co. Inc., 1180 Rolle, Switzerland) into the gingival sulcus at the base of the papilla on the mesial aspect, then moving it coronally to the papilla tip. This was repeated on the distal aspect of the same papilla. The intensity of any bleeding thus provoked was graded on a 0 to 4 scale. Gingivitis was evaluated at baseline and on days 28 and 56. The *plaque index (PI-I)* (SILNESS & LÖE 1964) was assessed on the buccal and lingual aspect of each tooth. Disclosing solution was not used. The PI-I was determined at each examination. **Probing depths (PD)** were measured at six sites per tooth (mesiobuccal, buccal, distobuccal, distolingual, oral, mesiolingual) using the CP 12 periodontal probe. A specially fabricated acrylic stent (Fig. 2) allowed reproducible location of probing sites. The greatest change with regard to reduction of probing depth or gain of attachment was to be expected in about four to six weeks following pocket therapy (LÖE & SILNESS 1963, MORRISON et al. 1980, CERCEK et al. 1983, GARRETT 1983, THORNTON & GARNICH 1982). Therefore the various clinical parameters were not only evaluated 28, but also 56 days after baseline. To allow undisturbed wound healing, PD was measured only at baseline before treatment and on day 56 following therapy. The stent was also used for the assessment of the distance gingival margin to splint margin (GMS, recession). Such measurement allowed estimation of the shrinkage of the gingival tissue following therapy. The *relative attachment level (AL)* was calculated by adding the two distances PD and GMS. GMS was determined at baseline and on days 4, 14, 28, and 56. Data for the computation of AL were available from baseline and day 56.

Measurements of Treatment Time: Instrumentation was complete when inspection of the surface using the tip of a periodontal probe did not reveal residual calculus or plaque, and the surface was smooth and hard. The time that was used to treat a quadrant was measured in each subject. Four quadrants were evaluated per subject, i.e., two quadrants per instrument. A total of 40 measurements were evaluated per instrument.

Study Design: The split mouth experimental design was employed. Instruments were allocated to quadrants to ensure uniform distribution (ANTCZAK-BOUCKOMS et al. 1990), i.e., five subjects randomly assigned to group one received sonic scaling treatment in quadrants one and four and ultrasonic scaling treatment in quadrants two and three, five subjects in group two received sonic scaling in quadrants one and three, and ultrasonic scaling treatment in quadrants two and four, etc. The treatments and examinations were performed by two dentists: All treatments required in one subject were performed by one

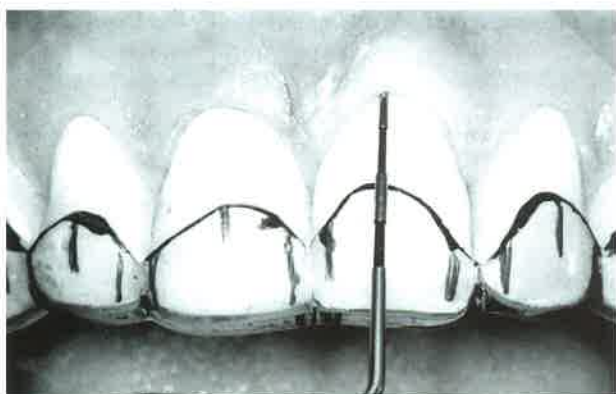


Fig. 2 The acrylic splint allowed the reproducible measurement of probing depth (vertical demarcation). The margin of the splint that follows the gingival contours was used for attachment level measurements.

dentist, and the examinations in that subject were made by the other dentist. The examiner was not aware of which instrument had been used to treat a particular quadrant. The assignment of subjects to the two dentists was dependent on the dentists' availability and was not based on randomization.

Before the study began, the dentists were calibrated with regard to PBI, PI-I, PD, and GMS. The calibration consisted of an instruction phase during which the dentists were allowed to discuss aspects of method, and of the calibration experiment. The results of the calibration experiment were evaluated using the k-statistics (FLEISS & CHILTON 1983). A k-value of >0.6 was considered acceptable.

Statistical Evaluation: The data recorded for individual sites were averaged per subject and per instrument. Per subject averages were used for statistical analysis. Following assessing the assumption that data within each treatment group were normally distributed with similar

variance, repeated measure analysis of variance was used for data analysis (Systat Statistical Program[®] Version 5). Data obtained from GCF measurements were not normally distributed. Original data were transformed to $\log(x, + 1)$, and repeated measures ANOVA was applied to the transformed values. Results were expressed as sample averages \pm standard error (SE). Sample size was determined basing on $\alpha = 0.05$ (level of significance), a clinically meaningful difference in attachment level of 0.20 mm, and a study power of > 0.8 . The estimated residuals' standard deviation was 0.16 mm.

Results

Results are presented in Figures 3 and 4 and Tables I and II. PI-I and GCF decreased after treatment. On day 4 the lowest PI-I and GCF were observed, followed by a slight increase of PI-I and GCF between days 4 and 14. At day 56 PI-I levels were still significantly smaller than at baseline and GCF resumed level at baseline. The changes with time in PI-I and GCF were statistically significant ($p < 0.001$) but the difference between the instruments was statistically not significant (PI-I, $p = 0.761$; GCF, $p = 0.529$). The one-time-treatment resulted in a statistically significantly improved PBI ($p < 0.001$). No statistically significant instrument effect was observed ($p = 0.907$). Treatment with either of the two instruments reduced probing depths slightly (mean reduction \pm SE: Titan-S[®]: 0.18 mm \pm 0.04 mm; Cavitron[®]: 0.21 mm \pm 0.06 mm). While the overall treatment effect was statistically significant ($p < 0.001$), there was no difference between the effects of the instruments ($p = 0.860$). Table II shows that the recession of the gingival margin was more pronounced in pockets exhibiting initial probing depths > 3 mm than in pockets with initial probing depths ≤ 3 mm (Table II). Tissue shrinkage was similar for both instruments. A minimal yet statistically significant ($p < 0.001$) increase with time in gingival recession (GMS) was observed. Apical migration of the gingival margin was

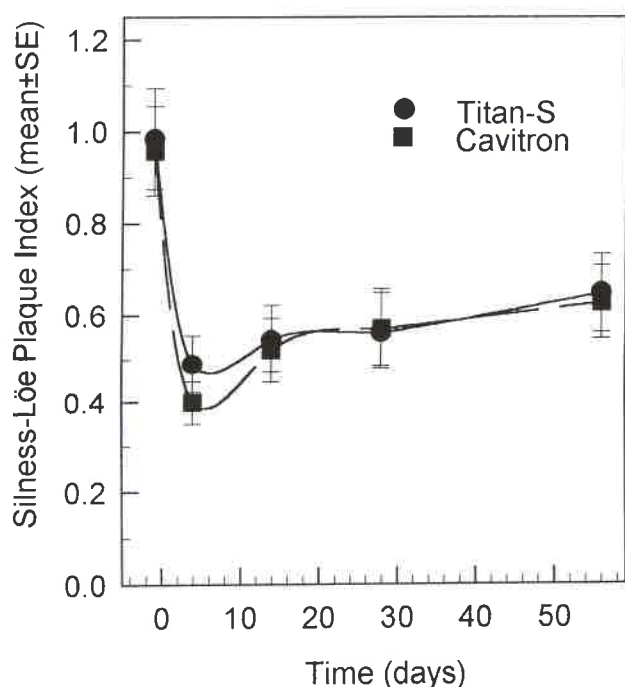


Fig. 3 Average plaque index ($\bar{x} \pm SE$) immediately before and after treatment using the Titan-S[®] sonic scaler or the Cavitron[®] 2002 ultrasonic scaler.

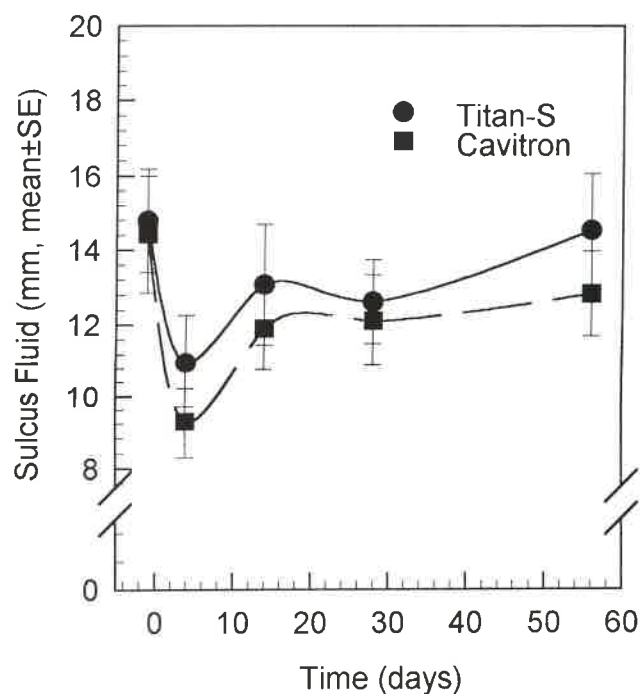


Fig. 4 Average sulcus fluid flow rate ($\bar{x} \pm SE$) immediately before and after treatment using the Titan-S[®] sonic scaler or the Cavitron[®] 2002 ultrasonic scaler.

Table I Changes in various clinical parameters as measured at baseline and following one-time treatment of subjects with gingivitis or slight periodontitis using the Cavitron® 2002 ultrasonic scaler or the Titan-S® sonic scaler. The results are expressed as mean \pm standard error of 20 subjects. "p"-values are for main effect "difference between instruments".

Parameter	Day of examination					p
	Baseline	4	14	28	56	
Papilla bleeding index						
Titan-S®	1.82 \pm 0.22	N.D.*	N.D.	1.16 \pm 0.20	1.13 \pm 0.18	0.907
Cavitron® 2002	1.90 \pm 0.17	N.D.	N.D.	1.27 \pm 0.16	1.03 \pm 0.16	
Probing depth (mm)						
Titan-S®	2.42 \pm 0.08	N.D.	N.D.	N.D.	2.24 \pm 0.08	0.596
Cavitron® 2002	2.38 \pm 0.07	N.D.	N.D.	N.D.	2.17 \pm 0.06	
Recession (mm)						
Titan-S®	2.76 \pm 0.11	2.88 \pm 0.14	2.88 \pm 0.13	2.85 \pm 0.13	2.82 \pm 0.11	0.860
Cavitron® 2002	2.69 \pm 0.12	2.88 \pm 0.14	2.84 \pm 0.14	2.81 \pm 0.14	2.81 \pm 0.13	
Relative attachment level (mm)						
Titan-S®	5.19 \pm 0.18	N.D.	N.D.	N.D.	5.06 \pm 0.17	0.696
Cavitron® 2002	5.07 \pm 0.17	N.D.	N.D.	N.D.	4.99 \pm 0.16	

* No measurement was made

Table II Frequency distribution of pockets relative to initial probing depths (PD), instrument used for treatment, and extent of gingival tissue change. A positive value for change of gingival margin level indicates pocket shrinkage.

Change of gingival margin level	Titan-S®	Cavitron® 2002	Titan-S®	Cavitron® 2002
	PD \leq 3 mm	PD \leq 3 mm	PD > 3 mm	PD > 3 mm
≥ -2 mm	10	8	0	0
-1 mm	167	180	1	1
no change	773	756	24	12
+ 1 mm	301	331	64	37
$\geq + 2$ mm	18	24	22	31
Total	1269	1299	111	81

most pronounced between baseline and day 4, later the location of the gingival margin did not show any major movement. There was statistically no significant difference in recession between the effects of the two instruments ($p = 0.860$). Treatment with either of the two instruments resulted in a slight but statistically significant gain in attachment level ($p = 0.004$). Subjects treated with the Titan-S® sonic scaler showed an average gain of attachment of $0.13 \text{ mm} \pm 0.05$. The attachment gain was slightly smaller after treatment with the Cavitron® 2002 ultrasonic scaler ($0.08 \text{ mm} \pm 0.05 \text{ mm}$). There was no statistically significant difference between the effects of the two instruments ($p = 0.085$).

The average treatment time per quadrant was 5.5 ± 0.47 minutes for the Titan-S® scaler and 5.9 ± 0.51 minutes for the Cavitron® 2002. The difference between instruments was statistically not significant ($p = 0.181$). Large variation was found for the time that was used to treat individual subjects ($p < 0.001$), and the interaction "instrument \times subject" was statistically significant at $p = 0.007$. For example, in one subject treatment with the Titan-S® sonic scaler lasted 8.2 min but 13.9 min were used with the Cavitron® ultrasonic scaler. In another subject, however, 10.5 min were used with the Titan-S® sonic scaler and 5.5 min were used with the Cavitron® 2002 ultrasonic scaler.

Discussion

Scaling and root planing are accepted modalities to treat periodontitis (GARRET 1983). The present study evaluated and compared the influence on clinical parameters of the Cavitron® ultrasonic scaler and the Titan-S® sonic scaler in subjects with moderate to severe gingivitis and/or slight periodontitis. All the parameters investigated showed significant reductions following treatment. Similar to the investigations of LÖE & SILNESS (1963) and DONZE et al. (1973), we found reduction of plaque 4 days following instrumentation (Fig. 3). Clinical signs of inflammation lessened as the plaque challenge decreased, and a reduction in GCF was observed. Also, some minor tissue shrinkage was noticed and evidenced by a slightly increased distance GMS (recession). After day 4, supra-gingival plaque recurred in clinically significant extent, indicating deficient oral hygiene by the subjects. This was not surprising because subjects did not receive oral hygiene instructions before or during the study. Parallel to the increase in plaque extent as measured by the Pl-I, a similar increase was apparent for GCF (Fig. 4). The direct relationship between GCF and the extent of gingival inflammation was initially shown by EGELBERG (1964) and later confirmed by RÜDIN et al. (1970). The present

study found close correlation between PI-I and GCF. A small reduction in PD was found to be the result of gingival shrinkage on one hand and clinical attachment gain on the other hand. There was a greater reduction in PD of pockets with initial PD > 3 mm than in pockets with initial PD ≤ 3 mm. On the whole, the changes in PD and AL were very small in the present study. This result was to be expected (LÖVDAL et al. 1961, BUCHANAN & ROBERTSON 1987) since the treatment was given to subjects with shallow, predominantly gingival pockets. In the majority of studies that compared ultrasonic scalers to hand instruments (BADERSTEN et al. 1981, DRISKO 1993), detailed instruction in oral hygiene was given to the subjects before treatment and reinforced during the study. In studies comparing sonic scalers with hand instruments (GELLIN et al. 1986, LAURELL & PETTERSON 1988), oral hygiene instructions were given with no exception. In the present study, oral hygiene instructions were intentionally not provided, thus allowing a better judgement of instrument effects on periodontal health. However, the subjects were given detailed oral hygiene instructions at study completion.

In an earlier in vitro study (LIE & LEKNES 1985) it was shown that the Titan-S® sonic scaler and the Cavitron® 2002 ultrasonic scaler were equally effective in removing calculus. The finding was confirmed in an in vivo study (LOOS et al. 1987) in patients with periodontitis who received a single treatment episode and were given a series of oral hygiene instructions at study beginning. All parameters measured in the present study indicated that there was no difference between the Titan-S® sonic scaler and the Cavitron® 2002 ultrasonic scaler with respect to their overall influence on clinical parameters.

The time that is used for scaling a tooth is dependent on the amount of plaque and calculus, its tenacity, the pocket depth and pocket morphology (RATEITSCHAK-PLÜSS et al. 1992). The average time of instrumentation in the present study was similar for the two instrument types. The relatively large variation of instrumentation time was related to between subjects differences in amount and extent of plaque and calculus. In addition, root sensitivity that could be observed during treatment with either one of the scalers showed great individual variation, thereby affecting treatment time to a lesser or greater extent.

Acknowledgment

We would like to thank Ms. Janice R. Braddy for preparing the manuscript. AFH received support from USPHS grant DE-07481 from NIDR.

Zusammenfassung

Die Gingivitis-/Parodontitisbehandlung bezweckt eine saubere Zahn- und Wurzeloberfläche mit dem Ziel, das Parodont von Entzündung zu befreien. Eine solche Therapie kann mit konventionellen Handinstrumenten, Schall- und Ultraschallscalern, Periojet®-Diamanten oder Perioplaner®-/Periopolisher®-Geräten erfolgen. In der vorliegenden klinischen Untersuchung wurde das Cavitron®-2002-Ultraschallgerät mit dem Titan-S®-Air-scaler an 20 Patienten mit Gingivitis oder leichter Parodontitis im Halbseitenversuch verglichen. Es handelte sich dabei jedoch vornehmlich um an Gingivitis erkrankte Patienten. Um mögliche Unterschiede zwischen den beiden Instrumenten deutlich machen zu können, wurde bewusst auf eine Mundhygieneinstruktion verzichtet. Die Patienten behielten also ihre mehr oder weniger schlechte Mundhygiene während des gesamten Stu-

dienverlaufs bei. Der Erfolg einer einmaligen Instrumentierung wurde nach 4, 14, 28 und 56 Tagen beurteilt. Die Parameter Sulkusfluid (GCF), Papillenblutungs-Index (PBI), Plaque-Index (PI-I), Sondierungstiefe (PD) und relatives Attachmentniveau (AL) wurden aufgenommen. Beide Behandlungsmodalitäten resultierten in einem statistisch signifikanten Rückgang der erfassten Entzündungsparameter ($p < 0,001$). Die Sondierungstiefen verringerten sich geringfügig, und ein Attachmentgewinn von $0,11 \text{ mm} \pm 0,05 \text{ mm}$ ($p < 0,001$) wurde beobachtet. Vier Tage nach der Behandlung kam es zu einem erheblichen, statistisch signifikanten Rückgang ($p < 0,001$) von GCF und PI-I im Vergleich zur Ausgangsuntersuchung. Der Einfluss beider Geräte auf die erhobenen klinischen Parameter war gleichermaßen erfolgreich. Es konnte kein statistisch signifikanter Unterschied zwischen den beiden Instrumenten festgestellt werden. Aufgrund der Ergebnisse lässt sich indirekt ableiten, dass sowohl das Cavitron®-2002- als auch das Titan-S®-Gerät sich im Rahmen der vorgestellten Versuchsbedingungen zur Zahn- und Wurzelreinigung eignen.

Résumé

L'objectif du traitement de la gingivite/parodontite est d'obtenir la propreté de la dent et de la surface radiculaire afin de juguler l'inflammation parodontale. Cette thérapie peut être assurée à l'aide d'instruments manuels conventionnels, de détartreurs soniques et ultrasoniques ainsi que d'appareils Periojet® ou Perioplaner®/Periopolisher®. La présente étude clinique, menée chez 20 patients atteints de gingivite ou de parodontite légère, visait à comparer le détartreur ultrasonique Cavitron® 2002 au détartreur sonique Titan-S®. Afin de pouvoir mettre clairement en évidence une éventuelle différence entre les deux instruments, les patients n'ont reçu aucune instruction d'hygiène, cette dernière se limitant durant l'étude à celle appliquée plus ou moins bien par eux-mêmes auparavant. L'effet d'une unique instrumentation a été évalué après 4, 14, 28 et 56 jours. Les paramètres suivants ont été mesurés: fluide gingival (GCF), indice de plaque (PI-I), profondeur de poche (PD) et niveau d'attache relatif (AL). Les deux types d'instrumentation ont engendré une régression statistiquement significative des signes cliniques d'inflammation ($p < 0,001$). Les profondeurs de poche ont pu diminuer et un gain d'attache de $0,11 \text{ mm} \pm 0,05 \text{ mm}$ ($p < 0,001$) a été observé. Quatre jours après l'instrumentation, on a constaté une importante régression statistiquement significative des indices GCF et PI-I par rapport à l'état initial. L'efficacité des deux appareils sur les paramètres cliniques élevés a révélé un égal succès et aucune différence statistiquement significative n'a pu être mise en évidence entre les deux méthodes. A la lumière des résultats, on peut conclure indirectement que dans les conditions expérimentales le Cavitron® 2002 et le Titan-S® sont tous deux indiqués pour le nettoyage des dents et des surfaces radiculaires.

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