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Pain during prophylaxis treatment elicited by two power-driven instruments

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Abstract

Background: Sonic scalers have an elliptical and piezoceramic ultrasonic scalers a linear oscillation pattern. Thus, a sonic scaler ''hammers'' the tooth surface, irrespective of its alignment to the tooth, whereas a piezoceramic ultrasonic scaler may oscillate parallel to the tooth surface and gently remove calculus if the alignment is correct. The aim of this study was to measure pain on a visual analogue scale (VAS) during removal of supragingival calculus on mandibular incisors with a sonic or an ultrasonic scaler.

Material and methods: Seventy-four periodontally healthy subjects with supragingival calculus on the mandibular incisors were treated with both a sonic and a piezoceramic ultrasonic scaler in a split-mouth design. The sequence of instrument application and allocation of instruments to jaw side were randomized. Patient comfort was assessed with a VAS after treatment.

Results: The VAS results did not show any difference between the two instrumentation modalities.

Conclusion: For calculus removal during prophylaxis the type of power-driven instrument does not seem to have an impact on perceived pain. This means that the oscillation pattern does not influence the pain experience.

Key words: instrumentation; pain; sonic scaler; ultrasonic scaler; VAS

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Supragingival calculus predisposes to the devolopment of periodontal disease by providing a retentive surface for plaque bacteria and impeting attempts to maintain adequate levels of plaque control (Friskopp & Hammarström 1980). It is the most widespread plaque-retentive factor and its removal is a prerequiste for the long-term success of periodontal therapy and prophylaxis (Lang et al. 2003). The dental profession spends a considerable amount of time removing supragingival calculus; its removal and polishing are one of the most often performed procedures in family dentistry and prophylaxis (Davies et al. 1997). Up to now there has not been much interest in mechanical techniques of supragingival calculus removal. Patients sometimes perceive pain during supragingival calculus removal. To increase patient compliance it is necessary to investigate aspect of this procedure, which affects the majority of each population in the Western world.

Over the past few years, a patient-centred approach has received more attention in periodontal research. Patients are not only interested in ''Dental'' outcomes, they also often ask for painless, less painful, or less aggressive treatment methods. If two treatment methods result in the same clinical outcomes and have the same costs, the patients preference will naturally be the less invasive or the less painful.

The expectation of pain during dental treatment or painful past experiences cause fear and thus avoidance of further visits to the dentist (Kleinknecht et al. 1973, Markgraf-Stiksrud, 1996). It is known that pain is a complex, specific sensory event, which consists of different sensory and emotional components. In the perception and personal experience of pain, individual psychological components play as important a role as the physiological processes of nociception. Fear and pain cause very similar vegetative reactions in an organism. Together they form a vicious circle, in which pain causes fear, and fear in turn, via tensing of muscles, can increase pain. In order to comprehend the total ''phenomenon of pain'', anatomical, physiological, and psychological knowledge is necessary. Only in this way is it possible for the doctor/dentist to individually assess the status of each patient (Eli 1992).

Besides hand instruments, sonic and ultrasonic instruments are used to remove

calcified deposits. The pressurized-air-powered sonic scaler oscillates at a frequency of ca. 6500 Hz and an amplitude of ca. 50 µm when not loaded, during which the working end moves in an elliptical pattern (Kocher & Plagmann 1997). Independent of the location of the working tip on the tooth, i.e., mesial, distal, buccal or lingual, substance removal is accomplished by small-area, hammering motions of the moving working end, which can be seen as an advantage of the sonic over the ultrasonic scalers. This operating mode allows more freedom in directing the instrument and easier positioning on the tooth. Piezoelectric ultrasonic scalers work at a frequency of ca. 20,000–35,000 Hz. The form of oscillation is largely linear, that is, in one plane, with an amplitude of 12–72 µm (Lea et al. 2003), meaning it is likely that not all surfaces of the instrument tip participate equally in debridement and that with optimal placement of the working end on the tooth surface, a purely scraping debridement pattern results. This is thought to be less unpleasant for the patient, since instead of hammering on the tooth surface, the instrument tip scrapes along it.

The less painful the treatment is, the higher is patient compliance with periodontal treatment and prophylaxis, and the better the long-term prognosis for maintaining a healthy periodontal status. The aim of the study was to document pain reaction during prophylaxis treatment with an air scaler and a piezoelectric ultrasonic device.

Materials and Methods

Seventy-four periodontally healthy patients of the Greifswald University dental clinic were examined (mean 25.2 ± 5.3 years, 34 males, 42 females) who had supragingival calculus on their mandibular incisors. They were given a written explanation of the background of the study, its objectives, and their involvement, and were requested to give their consent prior to enrollment in the study. The study was approved by the local ethics committee. All subjects were screened for their general health status using a medical questionnaire. The selection criteria were a minimum of 20 teeth. Exclusion criteria were presence of fixed orthodontic appliances, removable partial dentures, or periodontal pockets >4 mm.

In each patient, teeth 33–43 were treated. Supragingival calculus was removed in each patient with two different instruments. One quadrant was instrumented with a piezoelectric ultrasonic scaler (PiezonMaster 400, EMS, Nyon, Switzerland, insert ''A'', maximum power setting), and the other with a sonic scaler (Sonicflex2000, KaVo, Biberach, Germany, insert ''sickle'', no power adjustment possible). Tap water was used as coolant for the ultrasonic device and stored in a plastic bottle on the scaling device. The coolant of the sonic scaler was delivered directly from the dental unit. For both devices the coolants's temperature was about 22°C and irrigation volume 50 ml/min. To avoid overheating of the insert only conventional and no high volume evacuator were used, which was positioned sublingually in the molar region. The assignment of instrument to quadrant 3 or 4 and the sequence of instrument use was determined by a computer-generated randomized list. The participants were not informed as to which instrument was being used at a particular moment to remove calculus. Irrespective of calculus quantity instrumentation was performed for 2 min with each device. If there was left supragingival calculus, it was removed after the designated instrumentation time. Debridement time was stopped with a watch. If calculus was left, it was completely removed after the trial as well as polishing was performed.

The instrument tips of both devices were always held parallel to the tooth's long axis. Immediately following each type of calculus removal, patients indicated their pain perception of the respective instrument on two visual analogue scales (VAS). The VAS was graduated in the usual manner, i.e., from zero (no pain) to 10 (unbearable pain). Before treatment took place, the VAS was precisely explained to the patients, so they knew what to do after treatment (Melzack 1983, Tammaro et al. 1997). Results were evaluated with a Wilcoxon signed rank test (Statview 5.0 SAS, CA, USA).

Results

For the ultrasonic device, the average VAS value was 3.5 (SD ± 0.26), and for the air scaler, this was 3.7 (SD ± 0.24). The median was 3 for both instruments (Fig. 1). There were no significant differences in perceived pain depending on instrument used.

Where the air scaler showed a clear maximum VAS score of 3, the distribution of scores for the ultrasonic device differed. With the latter instrument, there was no clear maximum; rather, values of 1, 2 and 3 on the VAS were reported with similar frequency. Placing an arbitrary threshold at the VAS score of 4, 2/3 of the patients experienced no significant pain with either instrument. Further assuming another arbitrary limit at 7, it is obvious that only a very small proportion of patients perceived great pain (Fig. 2).

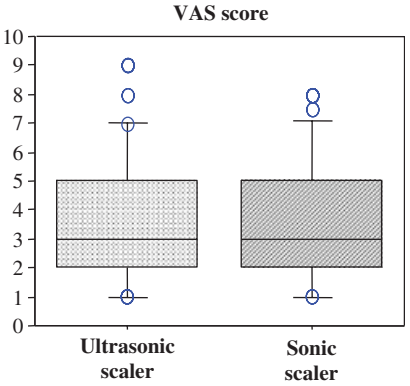

Fig 1. Box plot for the two instruments (median, outliers, 10%, 25%, 75% and 90% percentiles). VAS, visual analogue scale.

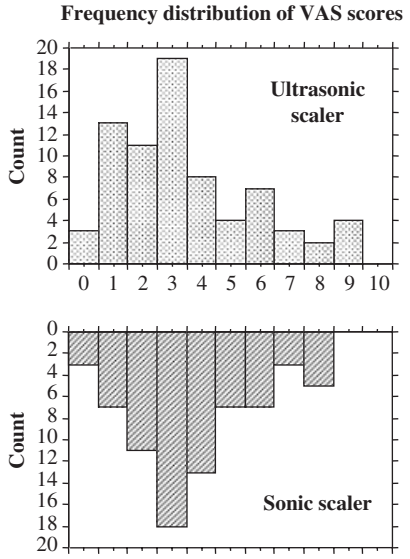

Fig 2. Frequency distribution of visual analogue scale (VAS) scores of the two calculus-removal devices.

Discussion

The VAS scores for the two power-driven scalers showed no significant difference in patients' perception of treatment: for both devices, patients reported relatively low pain. This positive assessment was independent of sequence of instrument use. Apparently, it is immaterial with respect to perceived pain whether an instrument's tip ''hammers'' on the tooth via an elliptically oscillating tip – as is the case with the sonic scaler – or scrapes along the tooth's surface, which is the modus operandi of the piezoceramic ultrasonic device. On a cautionary note, however, it is difficult to orient the lateral side of the piezoceramic ultrasonic insert's oscillatory plane parallel and perpendicular to the tooth's surface, meaning that not only scraping but also hammering motions may have been performed. This would blur any distinctions in pain perception reported for the two instruments. The parallel and perpendicular orientation of the lateral tip side to the tooth's surface is often difficult in the patient's mouth, becoming moreso the farther one works distally-inter-dentally. Data are very scarce about possible damage which is caused by instrumentation with different power driven instruments at the cemento-enamel junction and the enamel (Plagmann et al. 1989, Jacobson et al. 1994).

The etiological background of pain during scaling is poorly understood. Enamel may break off easily at the cemento-enamel junction (Plagmann et al. 1989, Jacobson et al. 1994). Furthermore, cervical cementum (Schroeder 1987) is very thin, and it does not require many scaling strokes to remove the cementum completely. The consequent iatrogenic denudation of the root dentin is a complication of the scaling procedure (Coldiron et al. 1990, Zappa et al. 1991, Jacobson et al. 1994, Kocher et al. 2001) and a large number of dentinal tubules are exposed. The opened dentinal tubuli may be subject to hydrodynamic forces, and as a result, the patient may experience pain.

However, these pain values reported here are markedly higher than in another study conducted in our unit, in which we treated patients in maintenance therapy with a Cavitron device and Slimline tips at the lowest power setting possible. The latter patients were also asked to indicate their pain perception on a VAS; the median score was 0 (Kocher et al. 2005). It is not clear what was responsible for this result: the low power setting, the thinner and thus less rigid insert, or both. The comparison of pain scores from these two studies provides industry with an optimization potential in the development of low-pain instruments. In addition, the operator should adjust the power level to correspond to the calculus present, in order to avoid pain and the unnecessary loss of hard tooth substance.

Two studies using the Vector® instrument showed that the oscillation direction of an ultrasonic device influences pain perception (Braun et al. (2003), Kocher et al. 2005). In contrast to other piezoceramic ultrasonic devices, the Vector® produces oscillations parallel to the long axis of the instrument. According to the manufacturer, this device causes little pain, because the instrument's tip does not ''hammer'' on the tooth but instead moves parallel to the tooth's long axis. Clinical use of this instrument for initial treatment and maintenance therapy validated the manufacturer's claim: patients complained less frequently of pain than when treated with conventional ultrasonic devices or curettes.

Braun et al. (2003) recorded intensities of pain during periodontal treatment with a manometer: the patient was instructed to set the hand pressure in relation to the perceived intensity of pain. The advantage of their method is that pain can be recorded simultaneous to treatment. In contrast to their method, the VAS can only be used for a retrospective assessment of previous painful sensations. It only asks for a summarized assessment after the treatment. High peaks of painful sensations during the prophylaxis treatment may only be recorded imprecisely (Huskisson, 1983, Tammaro et al. 2000). More information is necessary on which parameters evoke pain during instrumentation. It is necessary to develop multichannel methods, which allow the recording of pain during instrumentation with a high resolution of time, and the simultaneous recording of the local path of instrumentation on the tooth. This would make it possible to pinpoint the component of instrumentation causing pain. Only if this is accomplished will studies with less variance be possible. In a further step, the acquired knowledge may allow the development of gentler ultrasonic devices, which nevertheless have enough power to remove calculus, not just uncalcified biofilm.

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References

Braun, A., Krause, F., Nolden, R. & Frentzen, M. (2003) Subjective intensity of pain during the treatment of periodontal lesions with the vector – system. *Journal of Periodontal Research* **38**, 135–140.

Coldiron, N. B., Yukna, R. A., Weir, J. & Caudill, R. F. (1990) A quantitative study of cementum removal with hand curettes. *Journal of Periodontology* **61**, 293–299.

Davies, R. M., Ellwood, R. P., Volpe, A. R. & Petrone, M. E. (1997) Supragingival calculus and periodontal disease. *Periodontology 2000* **15**, 74–83.

Eli, I. (1992) *Oral Pyschophysiology. STRESS, Pain and Behaviour in Dental Care*, pp. 41–58. Boca Rocca: CRC Press.

Friskopp, J. & Hammarström, L. (1980) A comparative scanning electron microscopic study of supragingival and subgingival calculus. *Journal of Periodontology* **51**, 553–562.

Huskisson, E. C. (1983) Visual analogue scale. In: Melzack, R. (eds). *Pain Measurement and Assessment*, pp. 33–37. New York: Raven Press.

Jacobson, L., Blomlöf, J. & Lindskog, S. (1994) Root surface texture after different scaling modalities. *Scandinavian Journal of Dental Research* **102**, 156–160.

Kleinknecht, R. A., Klepac, R. K. & Alexander, L. D. (1973) Origins and characteristics of fear of dentistry. *Journal of the American Dental Association* **86**, 842–848.

Kocher, T., Fanghänel, J., Sawaf, H. & Litz, R. (2001) Substance loss caused by scaling with different sonic scaler inserts-an in vitro study. *Journal of Clinical Periodontology* **28**, 9–15.

Kocher, T., Fanghänel, J., Schwahn, C. & Rühling, A.. Some aspects on instrumentation during maintenance accepted. *Journal of Clinical Periodontology*.

Kocher, T. & Plagmann, H.-Ch. (1997) The diamond-coated sonic scaler tip. Part I. Oscillation pattern of different sonic scaler inserts. *International Journal of Periodontics & Restorative Dentistry* **17**, 393–399.

Lang, N. P., Mombelli, A. & Attström, R. (2003) Dental plaque and calculus. In: Lindhe, J., Karring, T. & Lang, N. P. (eds). *Clinical Periodontology and Implant Dentistry*. Oxford: Blackwell Munksgaard.

Lea, S. C., Landini, G. & Walmsley, A. D. (2003) Displacement amplitude of ultrasonic scaler inserts. *Journal of Clinical Periodontoloy* **30**, 505–510.

Markgraf-Stiksrud, J (1996) Angst und Angstabbau. In: Sergl, H. G. (eds). *Psychologie und Psychosomatik in der Zahnheilkunde*. München Wien Baltimore: Urban & Schwarzenberg.

Melzack, R. (1983) *Pain Measurement and Assessment*. New York: Raven Press, pp. 1–5.

Plagmann, H.-Chr., Wartenberg, M. & Kocher, Th. (1989) Schmelzoberflächen-veränderungen nach Zahnsteinentfernung. *Deutsche Zahnärztliche Zeitschrift* **44**, 285–288.

Schroeder, H. (1987) *Orale Strukturbiologie*, pp. 144. Stuttgart: Thieme.

Tammaro, S., Berggren, U. & Bergenholz, G. (1997) Representation of verbal pain on a visual analogue scale by dental patients and dental students. *European Journal of Oral Science* **105**, 207–212.

Tammaro, S., Wennström, J. L. & Bergenholtz, G. (2000) Root-dentin sensitivity following non-surgical periodontal treatment. *Journal of Clinical Periodontology* **27**, 690–699.

Zappa, U., Smith, B., Simona, C., Graf, H., Case, D. & Kim, W. (1991) Root substance removal by scaling and root planing. *Journal of Periodontology* **62**, 750–754.

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