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Full-mouth ultrasonic debridement *versus* quadrant scaling and root planing as an initial approach in the treatment of chronic periodontitis

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Abstract

Aim: To evaluate the clinical efficacy of (i) a single session of ''full-mouth ultrasonic debridement'' (Fm-UD) as an initial periodontal treatment approach and (ii) re-instrumentation of periodontal pockets not properly responding to initial subgingival instrumentation.

Methods: Forty-one patients, having on the average 35 periodontal sites with probing pocket depth (PPD) $\geqslant 5$ mm, were randomly assigned to two different treatment protocols following stratification for smoking : a single session of full-mouth subgingival instrumentation using a piezoceramic ultrasonic device (EMS PiezonMaster 400, A+PerioSlim tips) with water coolant (Fm-UD) or quadrant scaling/root planing (Q-SRP) with hand instruments . At 3 months, all sites with remaining PPD $\geqslant 5$ mm were subjected to repeated debridement with either the ultrasonic device or hand instruments. Plaque, PPD, relative attachment level (RAL) and bleeding following pocket probing (BoP) were assessed at baseline, 3 and 6 months. Primary efficacy variables were percentage of ''closed pockets'' (PPD $\leqslant 4$ mm), and changes in BoP, PPD and RAL.

Results: The percentage of ''closed pockets'' was 58% at 3 months for the Fm-UD approach and 66% for the Q-SRP approach ($p > 0.05$). Both treatment groups showed a mean reduction in PPD of 1.8 mm, while the mean RAL gain amounted to 1.3 mm for Fm-UD and 1.2 mm for Q-SRP ($p > 0.05$). The re-treatment at 3 months resulted in a further mean PPD reduction of 0.4 mm and RAL gain of 0.3 mm at 6 months, independent of the use of ultrasonic or hand instruments. The efficiency of the initial treatment phase (time used for instrumentation/number of pockets closed) was significantly higher for the Fm-UD than the Q-SRP approach: 3.3 *versus* 8.8 min. per closed pocket ($p < 0.01$). The efficiency of the re-treatment session at 3 months was 11.5 min. for ultrasonic and 12.6 min. for hand instrumentation ($p > 0.05$).

Conclusion: The results demonstrated that a single session of Fm-UD is a justified initial treatment approach that offers tangible benefits for the chronic periodontitis patient.

Key words: clinical; debridement; multicentre; periodontitis; randomized-controlled trial; root planing; scaling; ultrasonic

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The main goal in the treatment of patients with periodontitis is to establish and maintain adequate infection control in the dentogingival area. Root/pocket instrumentation (scaling and root planing), combined with effective self-performed supragingival plaque control measures, serves this purpose by altering the subgingival ecological environment

through disruption of the microbial biofilm and suppression of the inflammation. According to recent systematic reviews (Tunkel et al. 2002, van der Weijden & Timmerman 2002, Hallmon & Rees 2003), there is no major difference in the efficacy of debridement techniques using hand- or power-driven instruments in terms of pocket reduction and gain in clinical attachment. While Tunkel et al. (2002) concluded, based on their systematic review, that the use of ultrasonic/sonic devices requires less treatment time than manual instrumentation, Hallmon & Rees (2003), in a comparable review, considered that there is insufficient evidence to make any conclusion regarding differences in treatment time.

The traditional modality as an initial periodontal treatment phase has been to perform scaling and root planing by jaw quadrant (Q-SRP) at a series of appointments (Badersten et al. 1984a). More recently, Quirynen et al. (1995) advocated the benefit of performing full-mouth SRP within 24 h in order to prevent re-infection of the treated sites from the remaining untreated periodontal pockets. The authors also considered the risk of re-infection from other intra-oral niches such as the tongue and tonsils, and therefore included tongue cleaning and an extensive anti-microbial regimen with chlorhexidine (full-mouth disinfection). In a series of studies (Quirynen et al. 1995, Bollen et al. 1996, 1998, Vandekerckhove et al. 1996, Mongardini et al. 1999), it was documented that this combined approach resulted in improved healing, as assessed by clinical and microbiological means, compared with Q-SRP with 2-week intervals. It was, however, shown in a subsequent study by the same research group (Quirynen et al. 2000) that the major part of the improved treatment outcome of the full-mouth disinfection approach was attributed to the SRP of all four quadrants within 24 h, rather than to the adjunctive chlorhexidine regimen.

Another consideration in relation to non-surgically performed SRP is the extent of root instrumentation required for periodontal healing. The original intention with SRP was not only to remove microbial biofilm and calculus but also ''contaminated'' root cementum or dentin in order to prepare a root surface biocompatible for soft-tissue healing. The rationale for performing root planing was based on the concept that bacterial endotoxins penetrate into the cementum (Hatfield & Baumhammers 1971, Aleo et al. 1974), a concept that was later disproved by data from experimental studies showing that the endotoxins were loosely adhering to the surface of the root cementum and not penetrating into it (e.g. Hughes & Smales 1986, Moore et al. 1986, Hughes et al. 1988, Cadosch et al. 2003). Hence, intentional removal of tooth structures by root planing during pocket/root instrumentation may not be considered as a prerequisite for periodontal healing (Nyman et al. 1986, 1988). Consequently, pocket/root instrumentation should preferably be carried out with instruments that cause minimal root substance removal, but are effective in disrupting the biofilm and removing calculus. In this respect, data reported in studies that evaluated root substance removal following the use of various manual and power-driven instruments (Ritz et al. 1991, Busslinger et al. 2001, Schmidlin et al. 2001) favour the use of ultrasonic devices.

The aim of this study was to evaluate the clinical efficacy of a single session of full-mouth ultrasonic debridement (Fm-UD) as an initial periodontal treatment approach in comparison with the traditional treatment modality of consecutive sessions of Q-SRP. An additional aim was to analyse the effect of re-instrumentation of periodontal pockets that were not responding properly to initial subgingival instrumentation.

Materials and Methods

The trial was designed as a randomized, controlled, single-masked and parallel group study of 6 months duration (Fig. 1), and was conducted at two centres (Department. of Periodontology, the Sahlgrenska Academy at Göteborg University, Sweden and a private dental office in Trento, Italy) during 2002. Approval of the study protocol by the Ethics Committee at Göteborg University was obtained, and all participating subjects provided informed consent before the start of the study.

Patient sample

Forty-two adult patients, 21 at each centre, with moderately advanced chronic periodontitis, were recruited

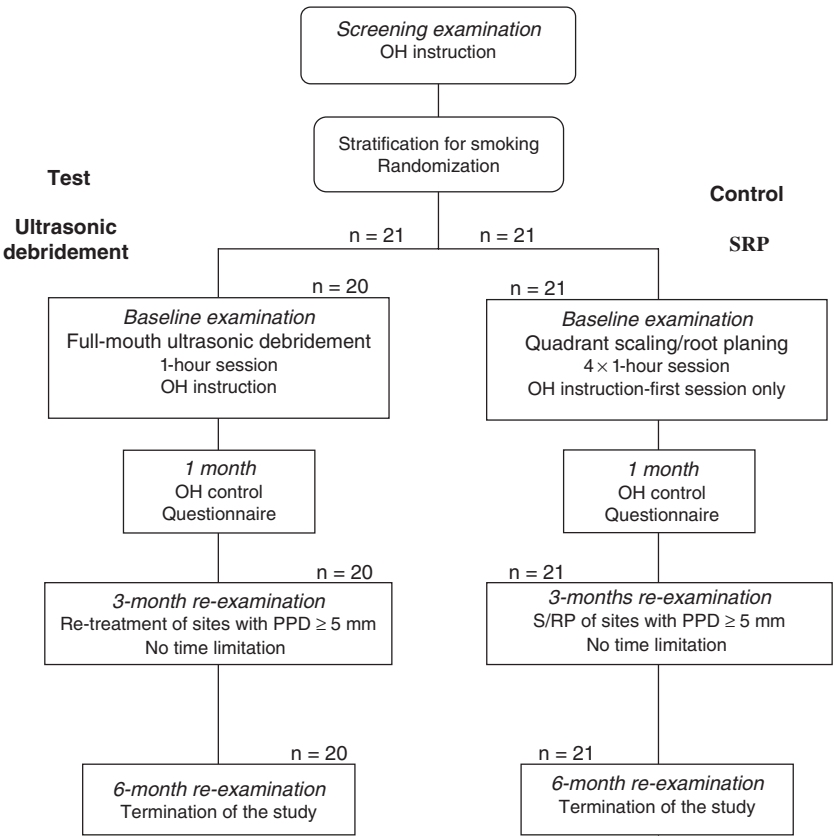

Fig. 1. Flowchart of the study outline. One of the 42 initially enrolled patients decided to exit from the study before the baseline examination/treatment session (test group).

for the study following a screening examination including full-mouth probing and radiographic evaluation. The following criteria were used in the selection of study subjects:

Inclusion criteria

- Age 25–75 years;
- A minimum of 18 teeth;
- At least eight teeth must show probing pocket depths (PPD) of $\geqslant 5$ mm and bleeding on probing (BOP). At least two of these teeth must have a PPD of $\geqslant 7$ mm and at additional two teeth, the pockets must measure $\geqslant 6$ mm;
- Unremarkable general health according to medical history and clinical judgement; and
- Female patients must not be pregnant.

Exclusion criteria

- Subgingival instrumentation within 12 months prior to the baseline examination;
- The use of antibiotics within 3 months prior to the start of the study;
- Compromised medical conditions requiring prophylactic antibiotic coverage; and
- Ongoing drug therapy that might affect the clinical signs and symptoms of periodontitis.

Power calculation based on the detection of a difference in the mean PPD reduction of 0.5 mm between treatment groups, assuming that the common standard deviation (SD) is 0.6 mm, and with an α error defined to 0.05 and β error defined to 0.20, revealed that 20 subjects in each treatment group were required.

Examinations

Full-mouth clinical examinations were performed immediately before treatment (baseline) and 3 and 6 months following the completion of the baseline treatment protocol (Fig. 1). All teeth and tooth sites, except third molars and tooth sites associated with furcation involvements of degree II and III (Hamp et al. 1975), were included in the examinations. The following variables were recorded at the mesial, buccal, distal and lingual surfaces of each tooth:

Plaque score: presence/absence of plaque at the cervical part of the tooth scored by running a probe along the tooth surface.
PPD: measured with a manual Hu–Friedy PCP15 periodontal probe (Hu–Friedy Inc., Leimen, Germany) to the closest lower millimetre.
BoP: presence/absence of bleeding within 15 s following pocket probing.
Location of gingival margin (GM): the distance between the GM and a fixed reference point on the tooth (cemento enamel injection (CEJ) or the margin of a restoration). A negative value was given when the gingival margin was located coronal to the CEJ.
Relative attachment level (RAL) was calculated as PPD+GM.

One examiner (a periodontist), who was masked with respect to the treatment assignments, performed all examinations. Before the start of the study, the examiner was trained to adequate levels of accuracy and reproducibility for the various clinical parameters and indices to be used (Polson 1997). Repeated assessments were performed during the course of the study on five randomly selected subjects in order to determine the intra-examiner reproducibility. The mean difference between repeated measurements was 0.03 (SD 0.43) for PPD and 0.06 (0.65) for RAL. The reproducibility within ± 1 mm was 97% for PPD and 91% for RAL assessments.

Stratification and randomization procedures

The enrolled subjects at each centre were stratified according to smoking habits, i.e. current smokers and non-smokers. Within each of these subgroups, a random assignment to the two treatment protocols (Fig. 1) was subsequently performed by the use of computer-generated tables. Allocation concealment was secured by (i) having a person not otherwise involved in the study performing the randomization and (ii) providing the centres (the dental hygienists) with sealed envelopes containing only the assignment for the individual subject. Based on the randomization procedure, 11 patients (four smokers) were assigned to the test treatment and 10 (four smokers) to the control treatment at the Italian centre. The corresponding numbers at the Swedish centre were 10 (seven smokers) and 11 (six smokers), respectively.

Treatment procedures

In conjunction with the screening examination (2–3 weeks before the start of the trial), the patients were given careful instructions in self-performed plaque control measures: twice-daily toothbrushing using the modified Bass brushing technique with a soft toothbrush and a regular toothpaste with fluoride, and once-daily inter-dental cleaning using triangular wooden toothpicks and/or inter-dental brushes. The standard of oral hygiene was checked at the baseline examination and at recall visits 1 and 3 months following baseline treatment (Fig. 1), and further instructions were given when indicated.

Fm-UD–test

The patients assigned to this treatment group received, at baseline (Day 0), a 1-h session of full-mouth subgingival debridement using a piezoceramic ultrasonic instrument (EMS Piezon Master 400 with A+PerioSlim tips, water coolant and power setting to 75%; EMS, Nyon, Switzerland). After re-examination at 3 months, re-instrumentation (no time restriction) with the use of the ultrasonic device was performed in all sites with a remaining PPD of $\geqslant 5$ mm.

Q-SRP – control

The patients in the SRP group were subjected to Q-SRP at four sessions with an interval of 1 week. An assortment of manual periodontal curettes was used (LM-dental, Turku, Finland). Following re-examination 3 months after completion of the baseline treatment, all sites with a remaining PPD of $\geqslant 5$ mm were carefully re-scaled and root planed (no time restriction).

For both treatment protocols, local analgesia was used if requested by the patient. The actual time used for instrumentation and the amount of local anaesthetics given (no. of 1.8 cm^3 cartridges) at each treatment session were recorded. Two dental hygienists, who were trained with regard to the various procedures included before the start of the study, carried out the treatment.

One month following the completion of the baseline treatment, all patients were recalled for professional *supragingival* plaque control and reinforcement of oral hygiene. Tooth cleaning was performed by the use of rubber cups and a low abrasive polishing paste but

no subgingival instrumentation was allowed. Information about experienced adverse events was obtained by the use of a questionnaire. The patients were also asked to judge the overall degree of treatment discomfort on a 100 mm visual analogue scale (VAS).

Data analysis

The primary efficacy variables were considered to be the percentage of ''closed pockets'', i.e. PPD $\leqslant$ 4 mm, and changes in BoP, PPD and RAL.

The data analysis was originally designed according to ''intent-to-treat'', i.e. data representing all subjects were to be included in the analyses at each time interval. However, one initially enrolled patient, randomly assigned to Fm-UD, decided to exit from the study before the baseline examination/treatment session because of failure to comply with the scheduled appointments for the study, and consequently no data from this subject were available for analysis according to the ''intent-to-treat''. Hence, the data analyses had to be limited to the 41 subjects who were available for the baseline examination.

Patient mean values were calculated as a basis for the statistical analysis. Mean values, SDs and proportions of sites within various categories of scoring units were calculated for data description.

The distribution of continuous variables was initially analysed with the Kolmogorov–Smirnov test. Difference in PPD between the groups at baseline was tested by the use of the Student *t*-test for independent samples. Changes in PPD and RAL were statistically analysed by the use of repeated-measures analysis of variance and differences in proportions with the use of 2 $\times$ 2 tables and Fisher exact test. Differences in mean proportions of ''closed pockets'' were analysed using the Mann–Whitney *U*-test.

As a descriptor of the efficiency of the two treatment protocols, the mean treatment time used to achieve closure (i.e. PPD $\leqslant$ 4 mm) of one pocket was determined (time used for instrumentation/number of pockets closed), and differences were analysed using the Mann–Whitney *U*-test. All statistical tests were two tailed and conducted at a significance level of $p < 0.05$.

All data handling and statistical testing were performed with the use of the SPSS 12.0 software package (SPSS Inc., Chicago, IL, USA).

Results

The characteristics of the patient sample are summarized in Table 1. All the 41 patients (mean age 49.8 years; range 27–70 years) who attended the baseline examination completed the 6-month study. The average number of sites showing a baseline PPD $\geqslant$ 5 mm (experimental sites) was 36 in the Fm-UD group and 35 in the Q-SRP group, out of which 33% and 29%, respectively, had a PPD $\geqslant$ 7 mm.

On average, 55 min. (SD 6) were used for instrumentation at the baseline session in the Fm-UD group, while the time used for baseline treatment in the control group (Q-SRP) was 168 min. (45). The time used for instrumentation during the re-treatment session at 3 months averaged 46 min. (29) in the SRP group and 51 min. (29) in the ultrasonic group. During the initial phase of treatment, the mean amount of anaesthetic solution used in the Fm-UD group was 1.4 cartridges (1.8), compared with 4.2 (2.5) in the Q-SRP group. At the re-treatment session, 3.1 (3.0) and 5.1 (3.1) cartridges, respectively, were required.

Since initial statistical analysis revealed no ''center–treatment'' interaction, pooling the data from the two centres involved in the study was considered justified.

Plaque scores

The oral hygiene status during the course of the study is illustrated in Fig. 2. At baseline, i.e. 2–3 weeks after oral hygiene instructions, the mean full-mouth plaque score was 22–23% in the two study groups, while 25–30% of the experimental sites harboured visible plaque. This standard of oral hygiene was maintained, or even slightly improved, during the study period. No statistically significant difference between the two treatment groups was observed at any of the examination intervals.

BOP

Following the baseline treatment, a marked reduction of the full-mouth BoP scores was observed in both treatment groups (Fig. 3). Hence, at the 3-month re-examination, the BoP score was reduced from 74% to 29% in the Fm-UD group and from 80% to 32% in the Q-SRP group. The re-treatment at 3 months resulted in a further reduction of BoP scores and, at the final examination, the BoP score was 23–24%. A similar pattern of reduction in BoP scores, although less pronounced, was observed when the data for only the experimental sites were analysed. Thus, at the 3-month re-examination, the BoP score varied between 44% and 48%, whereas at 6 months, both treatment groups displayed a BoP score of about 35%. There was no statistically significant difference in BoP scores between the Fm-UD and Q-SRP groups at any of the examination intervals.

Probing assessments

The mean baseline PPD varied between 6.1 and 6.2 mm for the Q-SRP and Fm-UD groups (Table 2). At the 3-month re-examination, the probing assessments revealed a mean PPD reduction of 1.8 mm and a mean RAL gain of 1.2–1.3 mm in the two treatment groups. The re-treatment of the remaining pathological pockets resulted in a further overall mean PPD reduction of 0.4 mm and a mean RAL gain of 0.3 mm at the 6-month re-examination. Analysing the data for only sites subjected to re-treatment, the mean PPD reduction amounted to 1.0 mm (ultrasonic instrumentation) and 0.8 mm (hand instrumentation), with an RAL gain of 0.7 and 0.6 mm, respectively. No significant differences were found between the treatment groups at any of the time

Table 1. Demographic characteristics of the patient sample

	Q-SRP	Fm-UD	Total
No. of patients enrolled	21	21	42
No. of patients – baseline examination	21	20*	41
Mean age	51.7	47.8	49.8
Gender (male/female)	10/11	12/8	22/19
Smokers	11	9	20

*One drop out (female, smoker) before baseline examination. Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

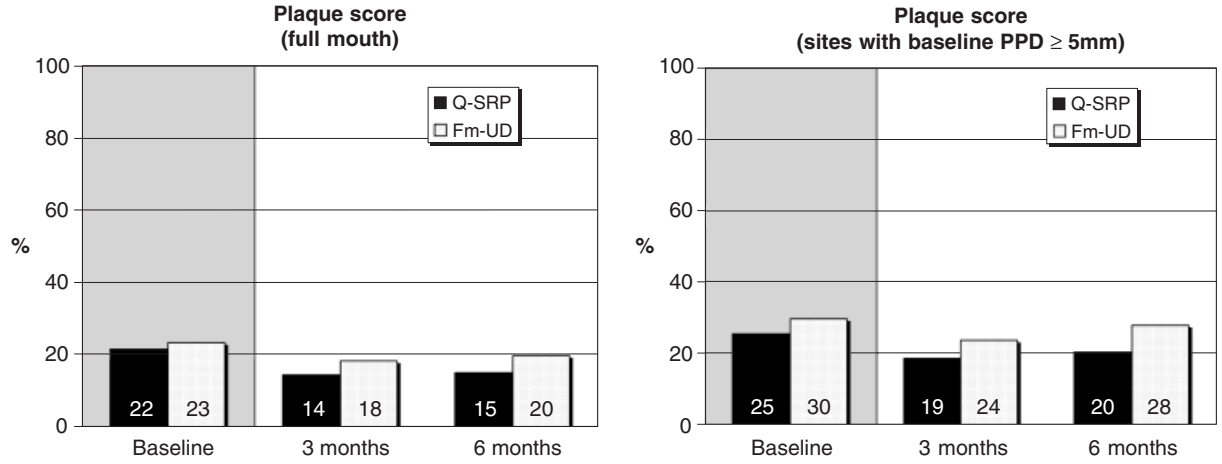

Fig. 2. Mean plaque scores at the various examination intervals based on full-mouth scoring and only sites with baseline probing pocket depth (PPD) ⩾5 mm (experimental sites).

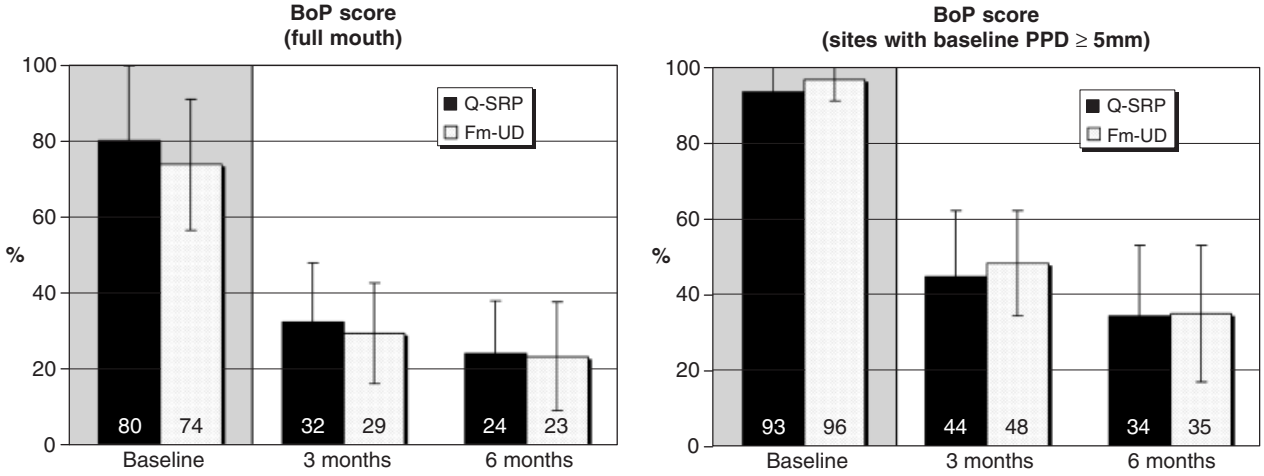

Fig. 3. Mean gingivitis score bleeding on probing (BoP) at the various examination intervals based on full-mouth scoring and only sites with baseline PPD ⩾5 mm (experimental sites). Mean values and standard deviation.

Table 2. PPD and RAL change at the various examination intervals

	Q-SRP	Fm-UD
Baseline PPD	6.1 (0.5)	6.2 (0.5)
PPD reduction		
3 month	1.8 (0.6)	1.8 (0.5)
6 month	2.2 (0.6)	2.2 (0.5)
RAL gain		
3 month	1.2 (0.4)	1.3 (0.5)
6 month	1.5 (0.5)	1.6 (0.4)

Mean values in mm (SD). Subject level. PPD, probing pocket depth; RAL, relative attachment level; PPD, probing pocket depth; RAL, relative attachment level; Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

Table 3. PPD and RAL change at the various examination intervals according to initial PPD category

Initial PPD	Q-SRP (mm)		Fm-UD (mm)	
	5–6	⩾7	5–6	⩾7
Baseline PPD	5.4 (0.2)	7.8 (0.5)	5.4 (0.2)	7.8 (0.4)
PPD change				
3 months	1.6 (0.5)	2.3 (0.9)	1.6 (0.4)	2.2 (0.8)
6 months	1.8 (0.5)	2.9 (0.7)	1.8 (0.4)	2.9 (0.7)
RAL gain				
3 months	1.1 (0.4)	1.6 (0.8)	1.1 (0.5)	1.7 (0.7)
6 months	1.3 (0.5)	2.1 (0.7)	1.3 (0.5)	2.2 (0.7)

Mean values in mm (SD). Subject level. PPD, probing pocket depth; RAL, relative attachment level; Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

intervals in terms of overall mean alterations or when the probing data were analysed according to baseline PPD categories (5–6 and ⩾7 mm; Table 3).

The probing assessments were further analysed with respect to proportions of sites showing ⩾2 mm change in PPD and RAL (Tables 4 and 5). With the Fm-UD approach, 50% of the sites with initially 5–6 mm deep pockets and 61% of the deep pockets (⩾7 mm) showed this magnitude of PPD reduction. The corresponding figures for the Q-SRP approach were 56% and 65%, respectively. At the final examination, the overall proportion of sites showing a

Table 4. Percentage of sites showing ⩾2 mm change in PPD between baseline and the various examination intervals

	Q-SRP		Fm-UD	
	improved	worsened	improved	worsened
Initial PPD (5–6 mm)	(*n* = 538)		(*n* = 462)	
3 months	55.8	0.2	50.0	0.4
6 months	68.2	0.4	65.6	0.4
Initial PPD (⩾7 mm)	(*n* = 218)		(*n* = 229)	
3 months	65.1	1.4	60.7	0.0
6 months	81.2	1.4	80.3	0.0

PPD, probing pocket depth; Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

Table 5. Percentage of sites showing ⩾2 mm gain or loss of clinical attachment (RAL) at the various examination intervals

	Q-SRP		Fm-UD	
	gain	loss	gain	loss
Initial PPD (5-6 mm)	(*n* = 538)		(*n* = 462)	
3 months	36.8	1.3	34.4	1.7
6 months	44.8	1.9	40.3	1.3
Initial PPD (⩾7 mm)	(*n* = 218)		(*n* = 229)	
3 months	48.6	4.1	46.3	0.9
6 months	64.7	1.8	61.1	0.9

PPD, probing pocket depth; RAL, relative attachment level; Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

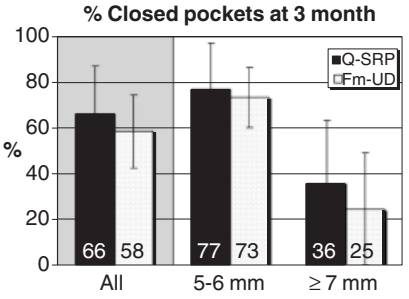

Fig. 4. Proportion (%) of pockets closed (probing pocket depth (PPD) ⩽4 mm) at the 3-month re-examination according to initial PPD. Mean values and standard deviation.

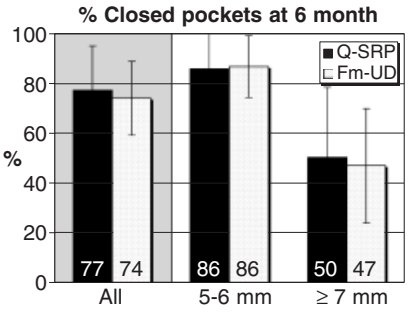

Fig. 5. Proportion (%) of pockets closed (probing pocket depth (PPD) ⩽4 mm) at 6-month re-examination according to initial PPD. Mean values and standard deviation.

PPD reduction of ⩾2 mm amounted to 71% in the Fm-UD and to 72% in the Q-SRP group.

A gain in RAL of ⩾2 mm was observed at 34% (Fm-UD) and 37% (Q-SRP) of the sites with an initial PPD of 5–6 mm, and in 46% (Fm-UD) and 49% (Q-SRP) of the initially deeper sites at 3 months (Table 5). The re-treatment performed resulted in a further improvement and at the 6-month examination interval, the corresponding figures were 40% and 61% (Fm-UD) and 45% and 65% (Q-SRP), respectively. The proportion of sites presenting ⩾2 mm loss of RAL varied between 1% and 2%, except for deep sites at the 3-month re-examination in the Q-SRP group (4%). Neither at the 3- nor at the 6-month re-examination were there any statistically significant differences between the treatment approaches with respect to proportions of sites with ⩾2 mm of change in PPD and RAL.

The proportion of sites reaching the successful treatment endpoint of ''pocket closure'', i.e. a PPD of ⩽4 mm, is presented in Figs 4 and 5. The initial treatment phase resulted in ''pocket closure'' at a mean frequency of 58% for the Fm-UD and 66% for the Q-SRP approach (Fig. 4). At 3 months, the Q-SRP showed a tendency to have a more favourable outcome in sites with PPD⩾7 mm compared with the Fm-UD approach (36% *versus* 25%). Following re-treatment of the remaining pockets, the mean percentage of closed pockets increased to 74% for Fm-UD and to 77% for Q-SRP (Fig. 5). For sites with an initial PPD of ⩾7 mm, the corresponding figure was 47% and 50%, respectively. No statistically significant differences were observed between the treatment groups at the various examination intervals.

Treatment efficiency

The efficiency of the treatment approaches was expressed as the number of minutes of instrumentation used to close 1 pocket (Table 6). For the initial treatment phase, the Fm-UD approach showed significantly higher efficiency than Q-SRP: 3.3 *versus* 8.8 min. per closed pocket ($p < 0.01$). Compared with the initial treatment phase, the efficiency of the re-treatment session at 3 months was markedly lower in both treatment groups (11.5–12.6 min.) and without significant difference between hand and ultrasonic instrumentation.

Table 6. Efficiency of the treatment procedures expressed as mean time in min. (SD) used to achieve one ''closed pocket'' (PPD⩽4 mm)

	Q-SRP	Fm-UD
Baseline treatment	8.8 (5.1)*	3.3 (1.4)
Re-treatment (3-month)	12.6 (10.7)	11.5 (11.3)

*$p < 0.01$ (Mann–Whitney *U*-test). PPD, probing pocket depth; Fm-UD, full-mouth ultrasonic debridement; Q-SRP, quadrant scaling/root planning.

Treatment discomfort

The subjective rating of the degree of treatment discomfort following the initial treatment phase revealed no difference between the two treatment approaches, median VAS scores 2.0 (range 0–5). One (5%) of the patients subjected to the Fm-UD approach reported increased root sensitivity for a

duration of $\geqslant 5$ days post-treatment, whereas the corresponding figure for the Q-SRP approach was seven (33%). None of the patients experienced acute problems (e.g. periodontal abscesses) during the study period.

Discussion

The present study demonstrated that in patients with moderately advanced periodontitis, an initial, single session of Fm-UD resulted in clinical improvements that were not significantly different from those following the traditional approach of consecutive sessions of Q-SRP. Further, comparable healing results were obtained following re-treatment of the remaining pathological pockets with ultrasonic instrumentation and root planing using hand instruments.

The ultimate goal with instrumentation of a pathological periodontal pocket is to render the root free from microbial deposits and calculus. However, a number of studies have demonstrated that this goal is frequently not attainable by SRP (e.g. Waerhaug 1978, Eaton et al. 1985, Caffesse et al. 1986, Brayer et al. 1989, Sherman et al. 1990, Wylam et al. 1993). Despite this fact, non-surgically performed SRP is an effective treatment modality for periodontal disease, as demonstrated by marked reduction in clinical signs and symptoms of the disease following treatment (for reviews, see Cobb 1996, 2002, Hung & Douglass 2002, van der Weijden & Timmerman 2002, Hallmon & Rees 2003). Taken together, these observations indicate that there may exist a threshold level of bacterial load following instrumentation below which the host can cope with the remaining infection (Cobb 2002). While probing of the root surface for detection of remaining deposits is an unreliable method to determine whether adequate debridement has been achieved (Sherman et al. 1990), clinical signs of resolution of the inflammatory lesion (e.g. lack of bleeding following probing, increased tissue resistance to probing and ''pocket closure'') would indicate sufficient removal of biofilm/calculus. In the present study, the latter criteria were used as outcome variables to determine the efficacy of different approaches to subgingival instrumentation. In an attempt to test what level of instrumentation might be required for periodontal healing, the initial Fm-UD approach was restricted to 1 h of instrumentation (i.e. about 2 min per tooth), while the control group was treated by a traditional approach of quadrant-SRP at four consecutive appointments (about 6.5 min. per tooth). Furthermore, in order to be able to evaluate the effect of the subgingival treatment properly, the patients were carefully monitored with regard to the standard of oral hygiene. Interestingly, re-evaluation after 3 months revealed similar degrees of improvements in clinical outcome variables for the test and control treatments: about 60% reduction in BoP, a mean PPD reduction of 1.8 mm and a mean RAL gain of approximately 1.3 mm. This magnitude of improvements is in accord with data reported in recent systematic reviews regarding outcome of SRP with hand- and machine-driven instruments in patients with chronic periodontitis (Tunkel et al. 2002, van der Weijden & Timmerman 2002, Hallmon & Rees 2003). Considering a PPD of $\leqslant 4$ mm as the successful endpoint of therapy, the current study showed a somewhat better outcome following Q-SRP (66% of all sites) than following the Fm-UD approach (58%). However, the efficiency of the treatment approaches, i.e. the time used for instrumentation during the initial phase of therapy in relation to the number of pockets reaching the endpoint of PPD$\leqslant 4$ mm, was significantly more favourable for the Fm-UD approach than for the traditional Q-SRP approach.

The positive outcome of the Fm-UD approach, despite the markedly reduced time for pocket/root instrumentation compared with the Q-SRP approach, may partly be explained by observations made in an in vitro study by Busslinger et al. (2001), showing that markedly less treatment time is required for root debridement with the use of a piezoelectric ultrasonic instrument compared with hand instruments. Further, the use of a thin periodontal probe-like insert for ultrasonic instrumentation, as used in the current study, may improve the efficacy of ultrasonic subgingival debridement (Dragoo 1992, Clifford et al. 1999). In a study involving 10 operators, Dragoo (1992) demonstrated that the use of a thin periodontal probe-like instrument tip offered advantages in terms of accessibility to deep periodontal pockets and efficacy in removing subgingival plaque/calculus compared with conventional ultrasonic tips and hand instruments.

To our knowledge, there is no clinical study available in the literature with a design to address the question as to whether the time used for instrumentation may affect the treatment outcome. In this context, however, one also has to consider that the experience of the operator may be an important factor influencing the efficacy of subgingival debridement (Brayer et al. 1989, Fleischer et al. 1989, Kocher et al. 1997). Although the dental hygienists at the two centres involved in the present study had different clinical experience (22 *versus* 8 years), no significant ''centre–-treatment'' interaction was identified, which may be ascribed to the pre-study training that was carried out. Moreover, whether a beneficial effect can be attributed to the fact that the entire dentition was instrumented at a single session may be argued. Quirynen and co-workers (Quirynen 1995, 2000, Bollen et al. 1996, Mongardini et al. 1999) demonstrated the benefit of performing full-mouth SRP within 24 h in order to prevent re-infection of the treated sites from the remaining untreated periodontal pockets. A recent study by Apatzidou & Kinane (2004), on the other hand, in which the full-mouth SRP was completed within 12 h, failed to confirm a positive effect of the full-mouth SRP approach compared with the traditional Q-SRP.

When interpreting the results from the present study, one should recall that, although the outcome of the Fm-UD as an *initial* treatment approach was not inferior to that following quadrant SRP, about 40% of the periodontal sites had not reached the successful treatment endpoint of ''pocket closure'' (PPD$\leqslant 4$ mm) at 3-month evaluation and, therefore, were in need of re-treatment. In order to provide the best possible outcome of the non-surgical therapy, no time restriction was set for the subgingival instrumentation during re-treatment, but rather the operator had to judge, based on her/his own clinical experience, as to when the sites had been properly debrided. The time analysis revealed that, on the average, 3.4 min. per remaining diseased pocket was spent for re-instrumentation using the ultrasonic device compared with 3.8 min./site with the hand instrumentation. However, independent of the use of ultrasonic or hand instruments, only additionally 11–16% of the total number of experimental sites were brought to a successful treatment endpoint at the

6-month examination, and about 50% of the pockets with an initial PPD ⩾ 7 mm still remained as non-successful sites. Also, other investigators have reported that the outcome of repeated episodes of non-surgical scaling and root planing is comparatively limited (Badersten et al. 1984b, Anderson et al. 1996, Wennström et al. 2001). Hence, an important issue to address in future studies is to identify factors, on the subject as well as on the site level that should be taken into consideration in the decision-making process regarding the benefit of repeated non-surgical root/pocket instrumentation or whether other treatment modalities (e.g. open-flap debridement, adjunctive antimicrobial therapy) should be selected for the individual site responding poorly to initial subgingival debridement.

In conclusion, the findings in the present study suggest that a one-stage ''Fm-UD'', combined with careful instructions in self-performed plaque control means, is a justified initial approach in the treatment of patients with chronic periodontitis. From the patient's perspective, this initial approach to subgingival infection control offers tangible benefits, in that fewer appointments and less chair-time for treatment are required compared with the traditional Q-SRP approach. Furthermore, the rated degree of discomfort experienced from the treatment was minimal, and less use of local anaesthesia was required than for Q-SRP with hand instruments.

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Clinical Relevance

Scientific rationale for the study: pocket/root instrumentation should effectively disrupt the biofilm and remove calculus, but cause minimal root substance removal. To test what level of instrumentation is required for periodontal healing, the clinical outcome of a single 1-h session of Fm-UD was evaluated.

Principal findings: The single session of ultrasonic debridement resulted in clinical improvements that were not significantly different from those observed in the control group treated by Q-SRP.

Practical implication: The 1-session ultrasonic approach combined with instructions in oral hygiene offers a rationale, initial approach to infection control in patients with chronic periodontitis.