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Effects of single-visit full-mouth ultrasonic debridement *versus* quadrant-wise ultrasonic debridement

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Abstract

Background: The aim of this randomized controlled clinical trial was to determine the effects of single-visit full-mouth ultrasonic debridement *versus* quadrant-wise therapy.

Material and Methods: Thirty-six subjects with chronic periodontitis, were randomly allocated to three groups – quadrant-wise ultrasonic debridement, single-visit full-mouth ultrasonic debridement with povidone iodine and single-visit full-mouth ultrasonic debridement with water. Whole-mouth plaque, bleeding on probing (BOP), pocket depth and attachment level were recorded before treatment and 1, 3 and 6 months post-treatment. Plaque and saliva samples were collected for microbiological analysis.

Results: After treatment, all groups showed significant improvement in clinical parameters. Full-mouth treatments resulted in similar improvements in full-mouth mean plaque percentage, probing pocket depth and probing attachment level as conventional therapy. When data were analysed based on pocket depth and tooth type, there was no difference between groups in probing depth reduction or attachment gains. The full-mouth groups demonstrated greater reduction in BOP% and number of pockets $\geqslant 5$ mm and the total treatment time was significantly shorter. The detection frequencies of periodontal pathogens in plaque and saliva showed slight changes with no difference between groups.

Conclusion: Single-visit full-mouth mechanical debridement may have limited additional benefits over quadrant-wise therapy in the treatment of periodontitis, but can be completed in a shorter time.

Key words: chronic periodontitis; full-mouth disinfection; non-surgical mechanical therapy; periodontal pathogens; polymerase chain reaction; povidone iodine; randomized clinical trial; single-visit ultrasonic debridement

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Non-surgical mechanical therapy, consisting of plaque control and mechanical debridement, constitutes the initial step in management of periodontal diseases. Adequate removal of pathogenic bacteria from the supra- and subgingival environment, by non-surgical mechanical periodontal therapy, is required for optimal healing of the diseased periodontal tissues. Conventionally, non-surgical mechanical therapy is performed in a quadrant- or sextant-wise manner with a time gap of 1 or 2 weeks between appointments. Thus, it usually takes 4–6 weeks or more to complete mechanical treatment of the whole mouth. Numerous clinical and microbiological studies have confirmed that non-surgical mechanical therapy performed in the conventional method is effective in reducing the bacterial load, resulting in clinical improvement (Knowles et al. 1979, Mousques et al. 1980, Badersten et al. 1981, 1984a, b, Magnusson et al. 1984, Hammerle et al. 1991, Haffajee et al. 1997). However, many studies have detected the presence of periodontal pathogens in other sites of the oral cavity, especially in extra-dental sites such as the dorsal surface of the tongue, buccal mucosa, palate and tonsils, in addition to the subgingival pockets (Zambon et al. 1981, Van Winkelhoff et al. 1986, Asikainen et al. 1991, Danser et al. 1994, Muller et al. 1997). It was also suggested that the main source

of periodontal pathogens re-emerging after periodontal treatment may be the own oral flora of the patient, although the role of an extra-oral source cannot be totally ruled out (Danser et al. 1996, Von Troil-Linden et al. 1996). The possibility of bacterial transmission, which may occur intra- or extra-orally, has been reported extensively (Alaluusua et al. 1991, Von Troil-Linden et al. 1995, Quirynen et al. 1996, 2001, Greenstein & Lamster 1997, van Steenbergen et al. 1997). With the existing evidence of intra- and extra-oral transmission of bacteria, it may be assumed that the interval between weekly/fortnightly appointments in quadrant-wise treatment provides an opportunity for periodontal pathogens residing in untreated pockets and other extra-dental sites to translocate to the treated pockets. If this transmission happens to occur in the earlier phase of healing, it is possible that it would adversely affect the healing of the diseased tissues by inducing re-infection. In order to verify this hypothesis, a new protocol, namely one-stage full-mouth disinfection, was introduced by Quirynen and co-workers in 1995 (Quirynen et al. 1995).

A series of clinical and microbiological studies conducted by Quirynen and his co-investigators reported that one-stage full-mouth disinfection resulted in significantly greater improvements than conventional quadrant-wise therapy (Quirynen et al. 1995, 1998, 1999, 2000, Mongardini et al. 1999). These studies demonstrating superior results with full-mouth mechanical debridement and adjunctive anti-microbial agents have raised the question whether the currently accepted approach with spaced appointments is adequate or appropriate as the initial treatment. Full-mouth treatment without the use of adjunctive anti-microbial agents was also capable of providing similar results as one-stage full-mouth disinfection, implying that extra-dental sites may not play a major role in the re-infection of treated pockets (Quirynen et al. 2000). In their study, both full-mouth treatments provided within 24 h resulted in superior improvements than the conventional quadrant-wise therapy. However, contradictory results were reported in a recent study conducted at a different treatment centre, which compared a full-mouth mechanical debridement excluding anti-microbial agents with the conventional quadrant-wise approach (Apatzidou & Kinane 2004a). Although the new treatment concept appears to be rational considering the infectious nature of periodontal disease, there appear to be few studies which have actually addressed this issue. The purpose of the present study was to compare the clinical and microbiological effects of single-visit full-mouth ultrasonic debridement with or without additional anti-microbial agents to those of conventional quadrant-wise therapy.

Material and Methods

Selection of subjects

A total of 36 systemically healthy, non-smoking patients, aged 34–66 years old (23 females and 13 males, mean 50.4 ± 8.4 years), were recruited from new referrals to the Periodontology clinic of Tokyo Medical and Dental University. All patients exhibited moderate-to-advanced chronic periodontitis, based on clinical and radiographic findings. The subjects had at least five teeth and two pocket sites with probing depth $\geqslant 5$ mm in each quadrant and radiographic evidence of bone loss. No subjects had received periodontal treatment and/or antibiotic therapy within the preceding 6 months. The characteristics of the subjects are shown in Table 1. Patients who were pregnant or lactating, or who were allergic to iodine were excluded from this randomized controlled study. Informed consent was obtained from all the subjects, after verbal and written explanation regarding the nature of the study. Prior to commencement, the study protocol was approved by the Ethics Committee of the Tokyo Medical and Dental University.

After screening, all subjects received one to two visits of toothbrushing instructions including the use of interproximal cleaning aids such as floss and inter-dental brushes, depending on individual needs. They were then randomly allocated to three groups based on the treatment protocol and the examiner was blinded to the allocation. The random sequence was computer generated, with no stratification or balancing of factors. The subjects chose a sequentially numbered opaque, sealed envelope, which enclosed the code for the treatment protocol they were to receive. The number of envelopes was same as the number of subjects. The treatment groups were coded so that only the operator was aware of the protocol and the examiner remained blinded throughout the study.

Clinical examination

All subjects were examined at baseline (before treatment), 1 month, 3 months and 6 months after completion of treatment by a single calibrated and blinded examiner. Calibration exercises for probing measurements were performed in six untreated patients before the actual study. Full-mouth clinical measurements of plaque percentage (Pl%), bleeding on probing (BOP%), probing pocket depth (PPD) and probing attachment level (PAL) were recorded using a manual probe (PCP-UNC 15, Hu-Friedy Manufacturing Co., Chicago, IL, USA) in all six sites of each tooth. Plaque was dichotomously scored as present or absent after running the probe along the gingival margin and bleeding was recorded as present or absent after completing the probing on the buccal or lingual of each quadrant. PPD was measured from the base of the pocket to the gingival margin. Attachment level was determined using a custom-made hard acrylic occlusal stent. The stent served as a reference guide for measuring PAL and attachment gain or loss was calculated from the measurements of PAL at baseline and at 1, 3 and 6 months. The clinical data were collected from the quadrant-wise mechanical therapy group 1 month, 3 months and 6 months after completion of the treatment in all four quadrants. The research schedule in the three treatment groups is shown in Fig. 1.

Patients' perception of the treatment was also recorded based on a self-filled questionnaire. Using a Visual Analogue Scale (VAS) from 1 to 10, the subjects were asked to mark the level of pain they experienced after treatment the same day and the next day. They were also instructed to record the number of analgesics taken after treatment and check the body temperature, the evening after treatment (approximately 3 h after treatment) and next day morning with a thermometer placed in the axilla. The subjects were asked to report any incidence of fever or other adverse reactions. The total time taken for instrumentation was noted by the operator.

Treatment protocol

After random allocation, the patients in this study were subjected to one of the three treatment protocols: conventional quadrant-wise mechanical debridement (QMD), full-mouth mechanical debridement with water in a single visit

Table 1. Patient characteristics at baseline

Treatment group	No. of subjects	Age* (years)	No. of male:female	Full-mouth Pl%*	Full-mouth BOP%*	Full-mouth PPD (mm)*	Mean PPD of sites ⩾5 mm*	No. of sites ⩾5 mm*
FMD+povidone	12	48.75 ± 8.9	4:8	23.28 ± 14.6	74.68 ± 15.4	4.09 ± 0.89	6.32 ± 0.44	59.5 ± 33.6
FMD+water	12	50.75 ± 8.6	5:7	21.18 ± 16.2	76.58 ± 14.1	4.01 ± 0.62	6.29 ± 0.58	55 ± 19.6
QMD	12	51.67 ± 8.1	4:8	17.69 ± 14.2	63.53 ± 19.8	3.78 ± 0.63	6.3 ± 0.55	48.3 ± 22.1

FMD+povidone, full-mouth debridement with povidone; FMD+water, full-mouth debridement with water; QMD – quadrant-wise mechanical debridement; Pl%, plaque percentage; BOP, bleeding on probing; PPD, probing pocket depth. No significant difference between groups ($p > 0.05$).
*Mean ± standard deviation.

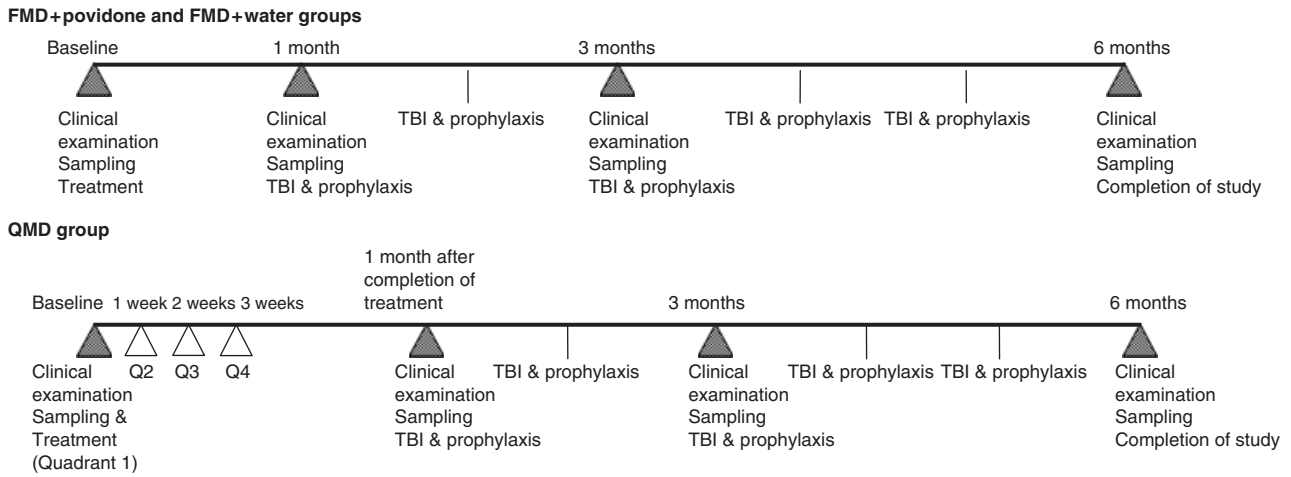

Fig. 1. Treatment schedule in the study groups FMD+povidone, full-mouth debridement with povidone; FMD+water, full-mouth debridement with water; QMD, quadrant-wise mechanical debridement; TBI, toothbrushing instructions.

(FMD+water) or full-mouth mechanical debridement with povidone iodine in a single visit (FMD+povidone). Mechanical debridement included supra- and subgingival ultrasonic instrumentation which was performed by two experienced and trained periodontists mainly with an ultrasonic scaler (Piezon® Master 400, EMS, Nyon, Switzerland) equipped with a Perio slim tip. Local anaesthesia was administered, if necessary, during debridement. In the QMD group, the teeth were supra- and subgingivally debrided in a quadrant-wise manner at weekly intervals, starting from the right maxillary quadrant with distilled water as irrigant in ultrasonic scaler. Distilled water was also used as irrigant in the FMD+water group, and mechanical debridement of all four quadrants was completed in a single visit. In the FMD+povidone group, mechanical debridement was performed in a single visit with 1% povidone iodine (Popiyodon Gargle®, Yoshida, Tokyo, Japan) as the irrigant. The subjects in this group were advised to rinse with 15 ml of 0.05% chlorhexidine (CHX) mouthwash (Concool®, Weltec, Mie, Japan) twice a day for 1 month and to practise tongue brushing in order to delay recolonization from other intra-oral niches during the initial healing period. Subjects in the QMD and FMD+water groups were not advised to use any mouthrinses or perform tongue brushing.

In addition to the above treatment protocols, subjects in all three groups were recalled every month for re-inforcement of oral hygiene instructions and professional tooth cleaning with a rubber cup and polishing paste. CHX stains, if any, were thus removed in these visits in the FMD+povidone group and the examination could be performed blinded. No ultrasonic scaling or other periodontal treatment was provided until the end of the study.

Microbiological analysis

Sample collection and preparation

Subgingival plaque samples were collected from the deepest pockets in each quadrant and pooled for microbiological analysis. The tooth was isolated with cotton rolls. Supragingival plaque along the gingival margin of the pocket site was wiped gently with a sterile cotton pellet. Subgingival plaque was collected by inserting a sterile paper point (No: 30) in the pocket until resistance was felt and kept in place for 30 s. Paper points with plaque samples were transferred to a sterile vial. Five hundred microlitres of unstimulated saliva was also collected from each patient in a sterile tube. The samples were stored at −80°C until analysis.

Polymerase chain reaction (PCR) detection

PCR detection was based on the amplification of signature sequences of the bacterial 16S rRNA genes. The primer sequences and PCR procedure were based on the report by Ashimoto and co-workers (Ashimoto et al. 1996). The bacterial species examined were *Actinobacillus actinomycetemcomitans*, *Tannerella forsythensis*, *Porphyromonas gingivalis* and *Treponema denticola*. The DNA templates for PCR amplification were prepared by heating the bacterial samples at 100°C for 10 min. followed by centrifugation to remove unbroken cells and large debris. The 50 μl PCR reaction mixture contained

5 μl of the sample, 5 μl of 10 × PCR buffer (Promega, Madison, WI, USA), 1.25 U Taq DNA polymerase (Promega), 0.2 mM of each deoxyribonucleotide (Pharmacia LKB, Piscataway, NJ, USA), 1.0 mM of each primer, and 1.0 mM $MgCl_2$ for *A. actinomycetemcomitans* or 1.5 mM $MgCl_2$ for *T. forsythensis*, *P. gingivalis* and *T. denticola*. PCR amplification was performed in a DNA thermal cycler (PTC-200, MJ Research, Boston, MA, USA). The temperature profile for *A. actinomycetemcomitans* included an initial step of 95°C for 2 min., followed by 36 cycles of 94°C for 30 s, 55°C for 1 min., 72°C for 2 min., and a final step of 72°C for 10 min. The PCR temperature profile for *T. forsythensis*, *P. gingivalis* and *T. denticola* included an initial step at 95°C for 2 min., followed by 36 cycles of 95°C for 30 s, 60°C for 1 min., 72°C for 1 min., and a final step of 72°C for 2 min. PCR amplification products were analysed by 1.0% agarose gel electrophoresis. The gel was stained with 0.01 mg/l ethidium bromide and photographed under ultraviolet light at 300 nm. A 100 bp DNA ladder digest (Promega) served as the molecular size marker.

Statistical analysis

The data were analysed with the subject as unit. Mean and standard deviations of each parameter were calculated for each patient and compared to determine any differences within and between groups. PPD and PAL were considered as the primary outcome variables. The improvements within group from baseline to post-treatment were analysed with paired *t*-test. The level of significance was set at 0.05. Analysis of covariance was used for comparison of the improvements in clinical and microbiological parameters between the three treatment groups adjusting for the potential difference in the baseline data and Bonferroni–Dunn test was performed post hoc with the level of significance at 0.01. All statistical analysis was carried out with the aid of statistical software (StatView® for Windows, Version 5.0, SAS Institute Inc., Cary, NC, USA). The power of the study, given 1 mm as a significant difference between groups, was calculated to be approximately 0.70.

Results

Clinical improvements

The study population was randomly divided into three groups with 12 subjects in each group. All subjects completed the study and were included for analysis. At baseline, there were no statistically significant differences between the three treatment groups in the demographic characteristics or the clinical parameters ($p > 0.05$) (Table 1). The treatment for full-mouth groups was completed in a single visit and that in the QMD group in four visits, approximately a month later than initiation of the treatment.

The improvements in clinical parameters 6 months after treatment are shown in Table 2. The full-mouth mean plaque scores improved significantly from baseline to 3 months and 6 months in all groups ($p < 0.05$) (Fig. 2). The full-mouth mean BOP also showed tremendous improvements after treatment in all groups ($p < 0.0001$) (Fig. 2). There was no statistically significant difference between the full-mouth and QMD groups in the reductions in Pl% at any time point (Table 2). However, the reduction in bleeding in the FMD+povidone and FMD+water groups was significantly greater than that in the QMD group ($p = 0.0025$, $p = 0.0008$ respectively) after 3 months. At 6 months, the FMD+water group still exhibited greater reduction in bleeding than the QMD group ($p = 0.0001$).

Calibration exercises for the probing measurements performed before the study indicated that there was an agreement of 95% to measurements within 1 mm. The correlation coefficient of duplicate measurements (r) was 0.86. The examiner was calibrated again during the study at 3 months in four patients and the correlation coefficient was 0.88.

Changes in PPDs in single- and multi-rooted teeth are shown in Tables 3 and 4. Regarding full-mouth PPD, there were significant reductions in all groups ($p < 0.0001$) at 1 month, 3 months and 6 months after treatment (Table 2). When only the pocket sites ⩾5 mm were considered, there were significant improvements ($p < 0.0001$) in the pocket depths after treatment (Table 2). However, the treatment groups demonstrated similar reductions in probing depth when both full-mouth measurements and pocket sites alone were analysed, with no evidence of any difference between groups ($p > 0.05$). Even when the data were split based on the tooth type (multi- and single-rooted) and pocket type (deep (⩾7 mm) and moderately deep (5–7 mm)), there appeared to be no difference between groups in reduction of PPD at the end of the study (Table 3). The number of pocket sites (⩾5 mm) was reduced significantly in all three groups 6 months after treatment, with greater reduction observed in the full-mouth groups (Table 2). The mean reduction in the number of pocket sites was 48.4 in the FMD+povidone group ($p = 0.0003$) and 45.5 in the FMD+water group ($p = 0.0068$), compared with 38.3 in the QMD group.

The changes in PAL in single- and multi-rooted teeth are shown in Table 4. All treatment groups exhibited gain in full-mouth attachment levels at 1 month, 3 months and 6 months. When the

Table 2. Improvements in clinical parameters at the end of the observation period

Treatment group	ΔPl%*	ΔBOP%*	Reduction in no. of sites ⩾5 mm*	ΔPPD*		Attachment gain*	
				full-mouth PPD (mm)	PD in sites ⩾5 mm (mm)	full-mouth ΔPAL (mm)	ΔPAL in sites ⩾5 mm (mm)
FMD+povidone ($n = 12$)	14.66 ± 12.8	56.4 ± 13.5	48.42 ± 26.3†	1.73 ± 0.6	3.05 ± 0.64	1.07 ± 0.4	2.01 ± 0.5
FMD+water ($n = 12$)	13.54 ± 13.2	61.9 ± 13.1†	45.5 ± 16.2†	1.74 ± 0.5	3.21 ± 0.66	1.2 ± 0.3	2.26 ± 0.6
QMD ($n = 12$)	12.95 ± 11.9	49.18 ± 17.6	38.33 ± 13.8	1.5 ± 0.3	3.06 ± 0.61	1 ± 0.2	1.99 ± 0.4

FMD+povidone, full-mouth debridement with povidone; FMD+water, full-mouth debridement with water; QMD, quadrant-wise mechanical debridement; Pl%, plaque percentage; BOP%, bleeding on probing percentage; PPD, probing pocket depth; PAL, probing attachment level.

*Mean ± standard deviation.

†Significantly different from QMD.

pocket sites greater than 5 mm were analysed, the results obtained were similar, with no evidence of any difference between groups (Table 2). When the data were split based on the tooth type and pocket type also, the full-mouth groups showed similar attachment gains as the QMD group. In terms of the attachment levels in multi-rooted teeth, the QMD group demonstrated greater, but not significant, attachment gain than the FMD+povidone group during most of the observation period.

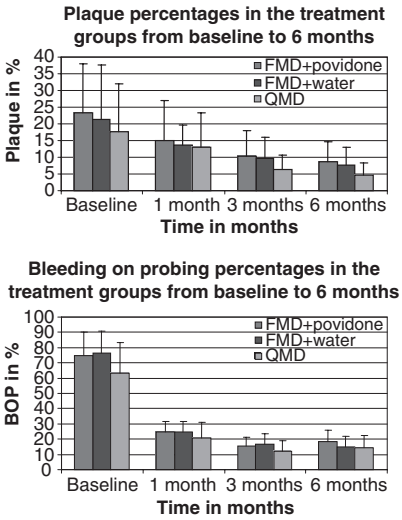

Fig. 2. Changes in full-mouth plaque and bleeding on probing percentages in the treatment groups.

The mean time taken for each treatment is shown in Table 5. While the FMD+povidone and FMD+water groups took an average of 2 h 19 min. and 2 h 7 min., respectively, the QMD group required 2 h and 58 min. to complete the whole-mouth treatment (Table 5). The total time taken for ultrasonic debridement of the whole mouth was significantly shorter in the full-mouth groups than the QMD group ($p < 0.0001$). The mean values of the VAS levels recorded by the patients were determined for each group. For the full-mouth treatments, the pain experienced after treatment was slightly higher than that recorded by subjects in the QMD group after completion of the scaling of quadrant 1, i.e. the first day of treatment and the next day. However, there was no significant difference between groups (Table 5). The number of analgesics reported by the patients showed a similar trend. The body temperature was recorded in the evening after treatment and next day morning. No patients in any of the groups reported any fever during this time. The mean of the temperature recorded in each group is shown in Table 5.

Effect of treatment on periodontal pathogens

The microbiological results are shown in Figs 3 and 4. Most of the subjects were positive for periodontal pathogens pre-treatment as detected by PCR. *A. actinomycetemcomitans* was very rarely detected in plaque and saliva in our study population. After treatment, there were slight and insignificant changes in the detection frequency of most of the periodontal pathogens in plaque. All treatment protocols resulted in very little reduction of the percentage of subjects who were positive for the four periodontal pathogens. Ten and 11 subjects still harboured *P. gingivalis* 3 and 6 months after FMD+povidone treatment, respectively. Eleven patients, who were positive for *P. gingivalis* in the FMD+water treatment group, were still positive. Seven out of the 10 initially positive subjects retained *P. gingivalis* after quadrant-wise treatment. The effects of treatment were more noticeable on the level of *T. denticola* in both plaque and saliva. *A. actinomycetemcomitans* was no more detectable in saliva after all three treatment protocols. When compared between groups, there was no significant difference in the detection frequency of the four periodontal pathogens.

Table 3. Probing depths in initially deep and moderately deep pockets

Treatment group	Single-rooted* (mm)				Multi-rooted* (mm)			
	moderate		deep		moderate		deep	
	baseline	6 months	baseline	6 months	baseline	6 months	baseline	6 months
FMD+povidone	5.42 ± 0.1	2.4 ± 0.2	7.92 ± 0.5	3.9 ± 1.4	5.44 ± 0.2	3.16 ± 0.5	8.0 ± 0.6	4.55 ± 1.4
FMD+water	5.43 ± 0.1	2.46 ± 0.5	7.74 ± 0.6	3.5 ± 1.4	5.49 ± 0.2	2.87 ± 0.6	8.2 ± 0.5	4.38 ± 0.6
QMD	5.3 ± 0.2	2.5 ± 0.5	7.46 ± 0.6	3.66 ± 1.2	5.34 ± 0.1	2.9 ± 0.6	8.1 ± 0.4	4.35 ± 1.1

FMD+povidone, full-mouth debridement with povidone; FMD+water; full-mouth debridement with water; QMD, quadrant-wise mechanical debridement; Moderate, pockets with initial pocket depth > 5 and < 7 mm; Deep, pockets with initial pocket depth ⩾ 7 mm.
*Mean ± standard deviation.

Table 4. Probing changes in initially deep and moderately deep pockets at 6 months

Treatment group	ΔProbing pocket depth* (mm)				Probing attachment gain* (mm)			
	single-rooted		multi-rooted		single-rooted		multi-rooted	
	deep	moderate	deep	moderate	deep	moderate	deep	moderate
FMD+povidone	4.02 ± 1.4	3 ± 0.2	3.44 ± 1.1	2.34 ± 0.7	2.74 ± 1.3	2 ± 0.6	2.28 ± 0.8	1.49 ± 0.4
FMD+water	4.26 ± 1.1	2.96 ± 0.5	3.81 ± 0.7	2.62 ± 0.6	3.3 ± 1	2.08 ± 0.6	3.02 ± 0.6	1.74 ± 0.6
QMD	3.8 ± 1.3	2.84 ± 0.6	3.9 ± 1.2	2.48 ± 0.6	2.83 ± 1.1	1.89 ± 0.6	2.64 ± 1	1.56 ± 0.3

FMD+povidone, full-mouth debridement with povidone; FMD+water, full-mouth debridement with water; QMD, quadrant-wise mechanical debridement; Deep, pockets with initial pocket depth ⩾ 7 mm; Moderate, pockets with initial pocket depth > 5 and < 7 mm.
*Mean ± standard deviation.

Table 5. Patients' perception about the treatment and total treatment time

	FMD+povidone	FMD+water	QMD
Level of pain (0–10)*, Day 0	3.06 (0.8–6.2)	2.99 (0–5)	2.03 (0–7)
Level of Pain (0–10)*, Day 1	2.1 (0–10)	1.8 (0–6.2)	0.58 (0–4.2)
Body temperature†, Day 0 (°C)	36.73 ± 0.52	36.23 ± 0.37	36.33 ± 0.46
Body temperature†, Day 1 (°C)	36.4 ± 0.55	36.13 ± 0.33	36.1 ± 0.48
No. of analgesics‡, Day 0	0 (0–1)	0 (0–2)	0 (0–2)
No. of analgesics‡, Day 1	0 (0–1)	0 (0–2)	0 (0–0)
Time taken to complete treatment (min)†	139 ± 23.6	127.58 ± 21.7	178.17 ± 33§,¶

FMD+povidone, full-mouth debridement; FMD+water, full-mouth debridement with water; QMD, quadrant-wise mechanical debridement; Day 0, same day after treatment (for QMD group, after the treatment of 1st quadrant); Day 1, next day after treatment (for QMD group, after the treatment of first quadrant).

*Mean (minimum–maximum).

†Mean ± standard deviation.

‡Median (minimum–maximum).

§$p = 0.0013$, statistically significant difference compared with FMD+povidone.

¶$p < 0.0001$, statistically significant difference compared with FMD+water.

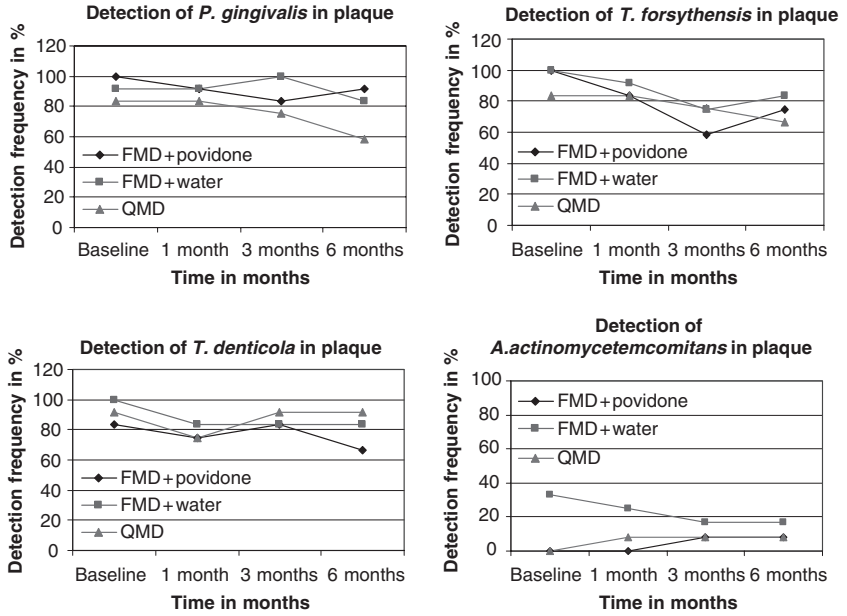

Fig. 3. Detection frequency of periodontal pathogens by polymerase chain reaction in plaque.

Discussion

Non-surgical mechanical periodontal therapy was effective in controlling moderate-to-advanced chronic periodontitis in our study subjects. Our findings were in agreement with previous studies which investigated the clinical effects of non-surgical periodontal therapy (Knowles et al. 1979, Badersten et al. 1981, 1984a, b, Hammerle et al. 1991, Haffajee et al. 1997). There were significant reductions in BOP and PPDs with corresponding gain in attachment levels in all groups. It is also interesting to note that this Japanese population exhibited a similar response to non-surgical mechanical treatment as the European populations. Previous studies investigating the full-mouth concept were also conducted in European populations.

In the present study, we modified the original protocol for one-stage full-mouth disinfection suggested by Quirynen (Quirynen et al. 1995). Quirynen and co-workers completed full-mouth mechanical therapy with curettes within 24 h in two consecutive visits and performed pocket irrigation and additional disinfection of other intra-oral niches with CHX. In addition to performing ultrasonic instrumentation with an antiseptic within the same day, we used CHX at 0.05% for mouth rinsing and included tongue brushing in the oral hygiene instructions. Mechanical therapy was completed in a single visit with an ultrasonic scaler running 1% povidone iodine as irrigant in our study. This was to complete the full-mouth treatment in the shortest time span possible and the irrigant was expected to disinfect the pockets as well as the oral mucosa and other intra-oral sites on contact during debridement. Ultrasonic instrumentation has been shown to be as effective as the use of manual scalers in removal of plaque and calculus and there was no difference in the clinical outcome (Drisko 1998, Drisko et al. 2000, Tunkel et al. 2002, Oda et al. 2004). It has also been reported that ultrasonic scaling requires significantly less time than curettes for instrumentation (Torfason et al. 1979, Badersten et al. 1984a, Jotikasthira et al. 1992, Copulos et al. 1993). Ultrasonic scalers also have the advantage of better accessibility to furcations and grooves, especially with the modified tips (Oda et al. 2004) and inclusion of anti-microbials for pocket debridement (Drisko et al. 2000). Hence, ultrasonic instrumentation was mainly used in the present study. Povidone iodine, which is known as a potential anti-microbial agent because of its broad anti-microbial spectrum, low resistance, ease of use and low financial cost (Greenstein 1999, Slots 2002), was used as irrigant for mechanical debridement in the FMD+povidone group. A few studies have utilized povidone iodine in varying concentrations to treat periodontitis patients and demonstrated that it may be effective as a subgingival irrigant (Grossi et al. 1997, Rosling et al. 2001, Hoang et al. 2003). However, we could not find evidence of any significant additional clinical benefit when povidone iodine was used in conjunction with mechanical debridement.

In addition to the irrigant, the patients were instructed to use CHX mouthwash at a concentration 0.05% for 1 month after treatment with the intention of delaying supragingival plaque formation and preventing recolonization of the pockets and oral niches. Most studies have utilized a concentration of 0.2% or 0.12% for control of supragingival plaque control (Lang et al. 1982, 1998, Gusberti et al. 1988). However, some recent studies have reported favourable results when using CHX in the concentration of 0.06% and 0.05% (Flemmig

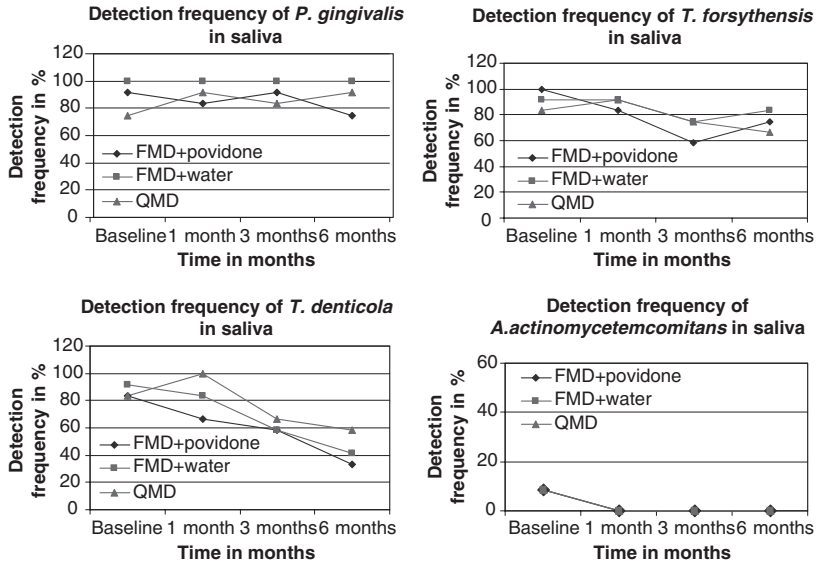

Fig. 4. Detection frequency of periodontal pathogens by polymerase chain reaction in saliva.

et al. 1990, Newman et al. 1990, Santos et al. 2004). The researchers suggested that by lowering the concentration of CHX, it might be possible to reduce the incidence of known adverse effects of higher concentrations, although it may compromise the effectiveness of CHX to some extent. The FMD+povidone group exhibited only minor additional reductions in the levels of plaque than the FMD+water and QMD groups, which could be explained by the use of CHX at 0.05%. In the present study, no subjects complained of any adverse reactions such as bad taste, burning sensation or staining, probably because of the low concentration of CHX. The absence of staining after 1 month use of CHX may also suggest that the antiseptic effect was small. Subjects in the FMD+water and QMD groups were not instructed to use CHX mouthwash and perform tongue brushing after treatment, so that we could observe whether the recolonization of the pockets occurring from extra-dental sites would affect the initial healing.

Published data from two treatment centres have reported the clinical effects of one-stage full-mouth treatment for periodontitis patients. Quirynen and co-workers from the Catholic University of Leuven observed that one-stage full-mouth disinfection resulted in significantly greater probing depth reductions and attachment gains than conventional therapy in chronic periodontitis patients (Bollen et al. 1998, Mongardini et al. 1999). Our results did not corroborate with the above-mentioned findings, which demonstrated superior results with full-mouth disinfection (Mongardini et al. 1999). Although we achieved similar pocket depth reductions as Quirynen and co-workers in the FMD+povidone group, the corresponding values for moderate and deep pockets in the QMD group were much greater than those reported by Quirynen (2.8 mm and 3.8 *versus* 1.2 mm and 1.9 in single-rooted teeth, 2.5 and 3.9 *versus* 0.7 and 1.6 mm in multi-rooted teeth). In our study, the clinical improvements in the full-mouth groups were similar to those observed by Quirynen and co-workers (Mongardini et al. 1999, Quirynen et al. 2000); however, the difference between the treatment groups was not significant. Despite modifications in the treatment protocol for full-mouth disinfection in our study, the treatment outcomes in both studies were alike. The major difference in the results between these two studies could be the greater probing improvements observed in the conventional treatment group in our study. Differences in the treatment protocol such as the use of CHX at a higher concentration for mouth rinsing and disinfection of all niches, the longer interval between treatment of quadrants (2 weeks), the absence of oral hygiene instructions before therapy and the recall frequency in the previous studies may explain the disparity in results. The severity of disease in the study subjects and the amount of calculus before treatment could be other factors. Most of these aspects which could increase the overall chances for cross-infection in the Leuven studies were modified in the present study. Particularly, the oral hygiene instructions provided to all subjects prior to the study may have reduced the chance for cross-infection even in the QMD group. The modifications in the treatment protocol may explain the good outcome for the QMD group in this study. Our findings were in agreement with results recently reported by Apatzidou & Kinane (2004a), who compared the effects of a single-visit debridement, using ultrasonic scaler and an assortment of curettes, with that of conventional quadrant-wise therapy in chronic periodontitis patients up to 6 months. The group reported a probing depth reduction of 4.3 and 4.4 mm in deep pockets for the quadrant-wise and full-mouth treatment groups, respectively, at the end of the observation period. The corresponding values in the present study were 3.7 and 4 mm for QMD and FMD+water groups, respectively. In moderately deep pockets, Apatzidou and Kinane observed pocket depth reductions of 2.5 and 2.3 mm in the full-mouth and quadrant scaling and root planing (SRP) groups, while we found reductions of 2.8 and 2.6 mm in the FMD+water and QMD groups. In both studies, the conventional treatment group exhibited a good response, comparable with the full-mouth treated groups. However, they reported greater gain in attachment level for deep pockets in the full-mouth group than the quadrant-wise treatment group. Similar to our study, this group completed the debridement in the same day and full-mouth periodontal charts were taken at each visit. Although we could not find any evidence of a difference in the probing changes, we were able to observe greater reduction in bleeding and number of pockets $\geqslant$5 mm in the full-mouth treated groups.

A treatment group, which received full-mouth ultrasonic debridement in a single visit without povidone iodine, CHX or tongue brushing, was included to determine the effect of the above components in the treatment protocol. The gingival changes were similar in the FMD+povidone and FMD+water groups, suggesting that the adjunctive use of anti-microbial agents applied in order to delay the recolonization of the pockets and disinfect the extra-dental sites may not have been necessary. In our study, both full-mouth treatments resulted in similar improvements as in

the conventional quadrant-wise therapy, implying that bacterial recolonization that occurs after incomplete treatment might not affect the clinical healing of treated periodontal tissues. Badersten et al. (1984b) had also reported no significant difference in clinical parameters when initial instrumentation was performed in a single visit or multiple visits and that pockets in non-molars can be effectively treated with a single episode of debridement. They suggested that recurrence of disease, that is possible because of translocation of bacteria, may not be a major problem clinically. The lack of evidence of a statistically significant difference between treatment groups in terms of the major outcome factors in the present study may have been because of the inadequate sample size. Although the present study had a similar sample size (36 subjects) as the report by Quirynen et al. (2000), the results obtained were not in agreement. However, Apatzidou & Kinane (2004a) also failed to demonstrate any difference between the two treatment protocols in a larger group of subjects. It would be essential to bear in mind the small sample size of the present study when interpreting the results.

The subjects in the present study did not experience any unfavourable side effects such as fever or herpes labialis. The pain experienced and number of analgesics taken by the subjects were comparable in all the treatment groups. These findings were in contrast to both previous reports, as a few patients in both full-mouth and conventional treatment groups complained of rise in temperature and herpes labialis in the studies by Quirynen (Bollen et al. 1998, Quirynen et al. 2000) and Apatzidou (Apatzidou & Kinane 2004a). The rise in temperature may be the result of an immune response to the large amounts of periodontal bacteria entering the bloodstream during mechanical debridement. It has been shown that subgingival scaling may elevate the circulating levels of pro-inflammatory cytokines such as interleukin-6 and tumour necrosis factor-α, which may account for pyrexia (Ide et al. 2004). Surprisingly, none of the subjects in our study reported any fever, although we performed the treatment in a single visit within 3 h.

PCR was employed for detection of the periodontal pathogens in this study. Many reports have indicated that PCR is a rapid and sensitive method for the detection of bacterial DNA sequences and this method is sensitive enough to detect periodontal pathogens below the normal detection level (Ashimoto et al. 1996, Riggio et al. 1996). Previous reports had shown elimination of the main bacteria, especially *P. gingivalis* as detected by culture methods after full-mouth treatment (Quirynen et al. 1999, 2000). Apatzidou et al. (2004b) also reported that mechanical treatment, both conventional and full-mouth protocols, resulted in marked reductions in the percentage of subjects who were positive for the main periodontal pathogens. Takamatsu et al. (1999) demonstrated that scaling and root planing resulted in a decrease in the detection frequency of *P. gingivalis* and *T. forsythensis* which corresponded with the clinical improvement. Several researchers have shown that non-surgical mechanical therapy could reduce the prevalence and levels of the main periodontal pathogens (Ali et al. 1992, Simonson et al. 1992, Shiloah & Patters 1994, Lowenguth et al. 1995, Haffajee et al. 1997). Haffajee et al. (1997) cautioned that radical alterations in subgingival microbiota may not be necessary or desirable after mechanical therapy. The subjects in our study were found to be positive for the DNA of the main periodontal pathogens even after mechanical treatment, although the subjects' clinical parameters improved markedly. This might indicate that it is rather difficult to eliminate the pathogens from subgingival plaque and saliva by mechanical means. These findings were in agreement with recent reports by Beikler et al. (2004) and Darby et al. (2001) who also could not demonstrate significant reductions in the detection frequency of periodontal pathogens at a subject level. It may be possible that the PCR technique would detect even the presence of few bacteria because of its high sensitivity, which may explain the insignificant changes observed in the detection frequency of bacteria at a subject level in the present study. However, as this method does not provide quantitative analysis of the pathogens, it may be difficult to conclude that there was no significant reduction in the pathogens. A quantitative analysis of the periodontal pathogens would be helpful to determine the actual impact of the treatment protocols on the bacterial load, especially when considering the concept of threshold number of bacteria (Haffajee & Socransky 1994, Doungudomdacha et al. 2001). Another explanation for the prevalence of bacteria after treatment could be the inadequacy of ultrasonic instrumentation to remove the bacteria. Results of our study suggested that there was no evidence of any difference in the detection frequencies of the main periodontal pathogens at a subject level between the three treatment groups. However, the similarity of the microbial composition in our study and other populations should be mentioned especially in terms of the high prevalence of *P. gingivalis*, *T. forsythensis* and *T. denticola* in the study population (Umeda et al. 1998, Apatzidou et al. 2004b).

The time taken to complete the treatment was significantly shorter in the full-mouth groups. As patients in the full-mouth groups were treated in one visit, the appointment time was longer, approximately 2–2$\frac{1}{2}$ h, in contrast to 40–50 min. per appointment in the quadrant-wise treatment and this might require a very tolerant patient. It would be convenient for some patients if the treatment can be completed in a single visit, particularly if it yields similar results as conventional treatment. However, effectiveness of a single-visit debridement may depend on the expertise of the operator. The full-mouth disinfection approach may be beneficial in conjunction with systemic antibiotics, especially for the control of aggressive forms of periodontal disease. It would be of interest to determine the effectiveness of this combined approach.

Within the limitations of the present study, it may be concluded that full-mouth ultrasonic debridement with or without adjunctive anti-microbial agents may have limited additional benefits over conventional quadrant-wise mechanical therapy, in terms of reduction of bleeding and number of pocket sites, and a shorter treatment time.

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Clinical relevance

Scientific rationale: Non-surgical mechanical periodontal therapy, when performed in the conventional method of four to six visits, may have the risk of re-colonization of the treated sites by periodontal bacteria from untreated pockets and other extra-dental sites. Whether this would affect periodontal healing needs to be further investigated.

Principal findings: A single-visit full-mouth ultrasonic debridement with or without anti-microbial agents resulted in similar clinical and microbiological improvements as quadrant-wise ultrasonic debridement. Recolonization that occurs after debridement in a quadrant-wise manner may not affect the periodontal healing.

Practical implications: Depending on the professional expertise of the operator and time available for treatment, it may be favourable to perform mechanical debridement in the shortest time span.