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The effectiveness of an individually tailored oral health educational programme on oral hygiene behaviour in patients with periodontal disease: a blinded randomized-controlled clinical trial (one-year follow-up)

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Abstract

Aim: To evaluate the effectiveness of an individually tailored oral health educational programme for oral hygiene self-care in patients with chronic periodontitis compared with the standard treatment.

Material and Method: A randomized, evaluator-blinded, controlled trial with two different active treatments were used with 113 subjects (60 females and 53 males) randomly allocated to an experimental or a control group. The individually tailored oral health educational programme was based on cognitive behavioural principles and the individual tailoring for each participant was based on participants' thoughts, intermediate, and long-term goals, and oral health status. The effect of the programmes on gingivitis [gingival index (GI)], oral hygiene [plaque indices (PlI) and self-report], and participants' global rating of treatment was evaluated 3 and 12months after oral health education and non-surgical treatment.

Results: Between baseline and the 12-month follow-up, the experimental group improved both GI and PlI more than the control group. The mean gain-score difference was 0.27 for global GI [99.2% confidence interval (CI): 0.16–0.39, $p < 0.001$] and 0.40 for proximal GI (99.2% CI: 0.27–0.53, $p < 0.001$). The mean gain-score difference was 0.16 for global PlI (99.2% CI: 0.03–0.30, $p = 0.001$), and 0.26 for proximal PlI (99.2% CI: 0.10–0.43, $p < 0.001$). The subjects in the experimental group reported a higher frequency of daily inter-dental cleaning and were more certain that they could maintain the attained level of behaviour change.

Conclusion: The individually tailored oral health educational programme was efficacious in improving long-term adherence to oral hygiene in periodontal treatment. The largest difference was for interproximal surfaces.

Key words: adherence; behavioural medicine; cognitive behavioural strategies; oral health educational programme; oral hygiene behaviour; periodontitis

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Conflict of interest and sources of funding statement

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For individuals with periodontal disease, a high standard of oral hygiene is one major factor for attaining and maintaining periodontal health (Nyman et al. 1975, Rosling 1983, Westfelt et al. 1998). Educational models based on a biopsychosocial perspective may have a potential for influencing an individual's capacity to maintain long-term oral hygiene control and are therefore of interest to test in oral health education. A biopsychosocial perspective expands the biomedical view by adding the influence of psychological and social factors to biological factors (Engel 1980).

Social cognitive theory (SCT) is a theoretical framework used for describing and understanding the different factors influencing health behaviour (Bandura 1997, Baranowski et al. 2002). SCT states that the characteristics and behaviour of a person and the environment in which the behaviour is performed interact with each other. The three components have a mutual influence and a change in one component may affect the others (Bandura 1997). Individually set goals rooted in a value system are a cognitively based source of motivation and guide for health habits. Long-term goals set a course of personal change whereas short-term attainable goals help people to succeed by enlisting effort and guiding action in the here and now (Bandura 1997). Strong self-efficacy beliefs (that a specific behaviour or task is attainable) correspond to more highly set goals and a firmer commitment to them (Bandura & Cervone 1983). Another cognitive process that appears to be important in achieving explicit goals is the perceived discrepancy between what a person actually does and what he/she seeks to do (Bandura & Cervone 1983). This is utilized in Motivational Interviewing (MI), where an essential strategy is to create discrepancies between what a client expresses regarding a specific health behaviour and the actual behaviour displayed (Miller & Rollnick 2002). When exploring an individual's motivation for change in oral hygiene behaviour, MI techniques can be useful as a tool for oral health professionals (Stewart et al. 1996, Harrison et al. 2007).

Few of the factors that promote the performance of health behaviour are used in the development of programmes for oral health, and specifically not in the treatment of patients with periodontal disease. In a Cochrane review (Renz et al. 2007), three randomized-controlled trial studies concerning psychological interventions and clinical markers of periodontal disease were identified. The conclusion was that psychological interventions may produce improvements in plaque and gingival scores as well as self-reported oral hygiene behaviour. Even if some studies are performed with an experimental design, there is a paucity of scientific evidence relating to patient behaviour, patient communication, patient education, and methods of supporting patients in developing effective oral self-care habits. Consequently, in this area, there is a need for methodological rigour in trial design and greater use of established theory for health prevention in the development of new interventions for improving oral health (SBU 2004, Renz et al. 2007).

In recent years, cognitive behavioural techniques such as formulation of goals, action, and coping plans, and self-monitoring have been integrated with interventions targeting inter-dental cleaning (Philippott et al. 2005, Jönsson et al. 2006, Schüz et al. 2006, Sniehotta et al. 2007). These studies are in line with Renz et al. (2007) and suggest that cognitive behavioural interventions are more effective than only information and oral hygiene instructions. However, oral hygiene interventions are conducted separately from periodontal debridement sessions (which are probably unusual in periodontal therapy in clinical settings). Oral hygiene instruction and information about periodontal disease are also standardized for all participants, i.e. a targeting approach for health prevention (Kreuter & Skinner 2000). Individual tailoring of treatment related to individual goals and problems may be more effective for reaching health goals than a targeting approach (Kreuter & Skinner 2000) and tailoring of oral hygiene intervention with social cognitive strategies has been successfully implemented and described in experimental single-case studies for patients with periodontal disease (Jönsson et al. 2009). It remains to be ascertained whether this kind of intervention is effective for a larger group of patients in periodontal treatment.

The aim of the present study was to evaluate the effectiveness of an individually tailored oral health educational programme based on a cognitive behavioural approach in patients with chronic periodontitis compared with standard treatment. It was hypothesized that both interventions would have positive effects, but that an individually tailored oral health educational programme would be more effective in reducing gingivitis. The effects on oral hygiene, participants' global rating of improvement, and treatment satisfaction were also studied.

Material and Method

Study design

A randomized, evaluator-blinded, controlled trial with two different active treatments was performed. Participants were randomly allocated to an individually tailored oral health educational programme (experimental group) or to a standard treatment programme (control group). The randomization was made in blocks of various sizes by a random computer table. Allocation concealment was secured by (i) having a person not involved with the clinic perform the randomization i.e. neither the examiner nor the therapist could influence the allocation of group belongings and (ii) providing the dental hygienists with sealed consecutively numbered envelopes containing only the assignment for an individual subject. The dental hygienist had not met the patient before the assignment. The sample was stratified for smoking and allocated to the two dental hygienists who performed the treatment.

Participants

The study was conducted at the department of Periodontology in a Swedish county with approximately 320,000 inhabitants. Participants were recruited among subjects with moderate to advanced periodontitis referred to the clinic and examined during the period from March 2006–March 2007. The subjects were referred from both public and private dentistry. The inclusion criteria were: participants clinically diagnosed with chronic periodontitis and scheduled to undergo a dental hygiene treatment (i.e. non-surgical periodontal debridement and intervention influen-

cing oral hygiene), aged between 20 and 65, literate in Swedish, and had a plaque index (PlI) according to Silness & Löe (1964) of $\geqslant 0.3$. The criteria for PlI were set for two reasons. Firstly, a high-standard of oral hygiene and a plaque level between 20% and 40% is suggested as a level compatible with maintenance of periodontal health (Lang & Tonetti 2003, Axelsson et al. 2004). Secondly, as both interventions aimed to improve oral hygiene habits, subjects with low plaque scores would have clinical efforts focused on other aspects besides oral hygiene.

Patients were excluded if they knew that they could not be available during any part of the study period, suffered from a serious disease that precluded regular sessions, and if explorative periodontal surgery was necessary before the dental hygiene treatment. The participants were requested not to begin any new or additional periodontal treatment during the study period (Fig. 1). A power calculation, with data from a previous study (Jönsson et al. 2006), based on the detection of a difference in the mean GI interproximally of 20% between treatment groups indicated that 75 participants were required in each group ($\alpha = 0.05$, $\beta = 0.2$).

Procedures

Initially, a full-mouth set of radiographs was obtained and the subjects were examined subsequently by a specialist in periodontology. A treatment plan, including preliminary costs for the treatment and maintenance care up to the 1-year follow-up visit, was presented. When all necessary pretreatment actions (e.g. tooth extraction and preliminary removable dentures) had been performed, the subjects were verbally invited by the periodontist to participate in the study. Each patient who agreed to participate received written information about the project and gave their written consent.

When the pretreatment routines finished, the participants were given a questionnaire, and asked to complete and return the questionnaire in a sealed envelope to the reception desk at the first dental hygienist session. The dental hygienists did not see the questionnaires. An identical questionnaire was used both at the 3-month and at the 1-year follow-ups. On these occasions, the participant received the questionnaire in advance by mail, and returned it to the reception desk at the follow-up session.

Clinical measurements (baseline, 3- and 12-month follow-up)

The same examiner, who was blind to group membership, performed all clinical measurements throughout the course of the study. Initially, health history including general health status, medication, smoking habits, and socio-economical status was collected. The clinical examination consisted of probing pocket depth (PPD) measured at six surfaces of each tooth, and bleeding on probing (BoP) in connection with the measurement of periodontal pockets. The presence of plaque was recorded according to Silness & Löe (1964) PlI. In the present study, criteria 2 and 3 were combined, i.e. all visible plaque was judged as the same amount. The presence of gingival inflammation was recorded according to the criteria for the gingival index (GI) of Löe & Silness (1963). Experience from patients treated for periodontal disease at the clinic indicates that few patients have spontaneous bleeding and ulcerations; therefore, criteria 2 and 3 were considered to be equally severe. Thus, the highest score for both PlI and GI was two. Both PlI and GI were recorded on the buccal, lingual, mesial, and distal tooth surfaces of all teeth. The mesial and distal surfaces were recorded from the lingual perspective. To minimize the risk of underestimating PlI and GI scores, the assessment was performed from the lingual aspect, as proximal surfaces are more accessible from the lingual aspect for the observer, but are probably more difficult for the individual patient when performing their oral hygiene.

The assessments for PlI, GI, PPD, and BoP were performed with a mirror and a periodontal probe (CC Williams Probe1-2-3-5-7-8-9-10, Hu-Friedy®, Chicago, IL, USA).

As both the GI and the PlI are well established in the clinical practice of the examiner, there was no calibration before the study. However, to secure the intra-observer reliability, five tests on plaque and gingival score were conducted throughout the study period. Four of the five measurements showed an almost perfect agreement (Cohen's κ 0.84–0.86), and one test revealed a moderate agreement (Cohen's κ 0.51). However, the percentage agreement was high, as only three of 24 measures differed.

Oral hygiene behaviour

Oral hygiene behaviour was assessed through questionnaires covering oral self-care habits such as frequency of

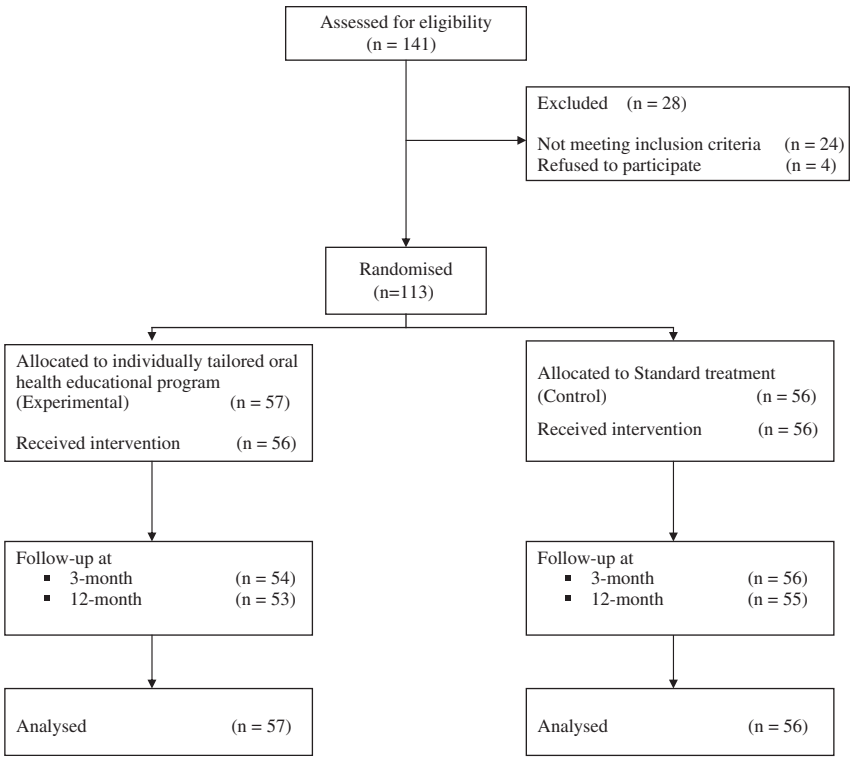

Fig. 1. Flow chart of the participants during the study.

toothbrushing and inter-dental cleaning, type of toothbrush and inter-dental cleaning aid, and time and place for oral cleaning. The toothbrushing and inter-dental cleaning were classified into two categories: brushing at least twice a day/less often and, cleaning proximal surfaces once a day/less often.

Participant rating of global improvement and treatment satisfaction

To evaluate participants' opinion about the interventions and satisfaction with the treatment, six questions were posed at the 12-month follow-up: (1) performance of oral self-care (much better, better, no difference, and worse) compared with before treatment; (2) satisfaction with oral health (much more satisfied, more satisfied, and no difference, worse) compared with before treatment; (3) compliance with skills obtained during the treatment (daily, several times a week, some times per week, a couple of times during a month, seldom/never); (4) likelihood to maintain new habits (very likely, likely, fairly likely, and not likely); (5) satisfaction with care given by the dental hygienist (very satisfied, satisfied, fairly unsatisfied, and very unsatisfied); and (6) whether the treatment had been worthwhile (time and cost) (yes, absolutely, yes, to some extent, neither yes nor no, and no).

Interventions

Two experienced dental hygienists provided both interventions, including the non-surgical debridement for both the experimental and the control groups. The number of sessions depended on individual needs for scaling treatment (i.e. severity of the periodontitis or amount of calculus), and were planned to vary between four and six sessions. In both groups, the participants visited the dental hygienist once a week until scaling treatment was finished. In addition, an oral hygiene control was performed after 1 month for both groups.

One of the dental hygienists (B. J.) designed the programme for the experimental intervention in co-operation with a psychologist (P. L). The programme was tested in a series of experimental single-case studies before the study (Jönsson et al. 2009). Before and during the implementation of the new intervention (experimental group), the second dental hygienist received special training from the project leader (B. J.). The training included three 8-h sessions covering education in MI techniques and the philosophy behind the use of cognitive behavioural strategies. The principles and strategies for implementation of the different components in the intervention were described in a manual. Before the study started, components from the intervention were tested on three subjects at the clinic. Video recordings monitored how well the intervention was followed. Some video recordings were discussed with a psychologist (P. L) at the start of the study, and strategies for implementations of goals and homework assessment and how to handle different situations were considered. A clinic-based supervision was performed during the course of the study. The standard treatment programme (control group) was in concordance with the dental hygienist's professional competence, and no special training was given. A treatment manual covering what to do in each session and illustrated information material were used to provide the same information about periodontal disease for all subjects in the control group.

Individually tailored oral health educational programme (experimental group)

The individually tailored oral health educational programme was based on the perspective of behavioural medicine, i.e. an integration of cognitive behavioural principles (Bandura 1977, 1997, Baranowski et al. 2002) and non-surgical periodontal treatment. The central theme of the programme was tailoring the treatment to each individual's problem, capacity, and goals, with subsequent guidance towards appropriate and effective oral hygiene habits. Special emphasis was placed on strategies that would fit as naturally as possible into everyday life. To create a ''dynamic dialogue'', specific skills in communication were required and therefore methods of MI were included. MI is characterized by reflective listening and is used in an attempt to understand the meaning of statements (Miller & Rollnick 2002).

The programme comprised seven separate components with different tactics for tailoring each individual's personal goals regarding oral health and dental hygiene habits.

1. *Initiation and analysis of knowledge, expectations, and motivation*

Initially, an interview with open-ended questions ascertained the patient's knowledge of periodontal disease, self-care habits, and attitude towards oral hygiene, as well as outcome expectations and experiences from earlier treatment. The extent to which information about dental diseases was provided depended on each patient's prior knowledge. The patient formulated (in writing) three to five personal general long-term goals related to oral health that were the most important to them.

2. *Analysis of oral hygiene behaviour*

Based on the above data, the dental hygienist made recommendations related to self-care interventions that were discussed with the patient. Disclosing solution was used to illustrate any current oral biofilm and to initiate a discussion related to oral hygiene aids that might support the patient's oral health goal. The patient's motivation to use various oral hygiene aids was explored. A guiding principle was to introduce only one oral hygiene aid at each session, which allowed the patient to use the chosen aid properly and at the desired frequencies, before any new aids were introduced.

3. *Practice of manual dexterity for oral hygiene aids*

The practice of manual dexterity was introduced when the patient's oral hygiene aid was chosen. Instruction sessions on ''what to do'' and ''how to do it'' were performed by the wash basin in front of a mirror to make the circumstances as near to a home routine as possible.

4. *Individual goals for oral hygiene behaviour*

At the end of each session, the patient's self-efficacy and readiness to change an oral hygiene habit was explored through a direct question. Subsequently, the oral hygiene procedures, how, when, and where to use the desired oral hygiene aid or aids, and which area should be given particular attention to until the next session were discussed and agreed upon. The action plan for oral self-care to the next session was formulated in writing. Patients were encouraged to start using the oral hygiene aid they deemed to have the best chance of being successful in reaching the intermediate goal.

5. *Continuous self-monitoring*

A short structured diary was provided to the patients for keeping records on their self-care between sessions. Recordings included the aids used, fre-

quency and when they were used, as well as associated factors that facilitated use or created barriers to use. The diary was discussed and analysed at the next appointment. Positive experiences were encouraged, problems were identified, and possible solutions to the problems were discussed.

6. *Generalization of behaviour*

When all self-care aids had been introduced and practiced, they had to be coordinated to function together. The individuals' preference, knowledge, and capacity to adapt to necessary oral hygiene aids differed between aids. The dental hygienist allowed the self-care process to develop in a way that supported individuals to proceed at their own pace.

7. *Maintenance of oral hygiene behaviour and prevention of relapse*

The patient was informed that relapses are common during behavioural change (Wilson 1992). Strategies for maintaining already achieved goals for oral hygiene were discussed. Specific risk situations for inter-dental cleaning relapse were identified (e.g. summer holiday, periods of work overload), and problem-solving strategies were discussed. The discussions focused on situations in which oral hygiene was facilitated and how to find solutions to the problems the patient encountered. If difficult/demanding situations were identified, a plan was constructed to prepare the patient on how to handle these situations. If there were signs of a relapse to previous oral hygiene habits, the disadvantages and advantages were discussed.

The components of the programme related to the treatment sessions are presented in Table 1.

Standard treatment (control group)

The control conditions were chosen to be equivalent to the best possible routine oral health preventive programme for patients with periodontal problems. The programme used corresponded to the description by Nyman et al. (1984) and by Rylander & Lindhe (1997). The programme (labelled *individual educational programme*) has been tested on young adults with satisfactory results (Hugoson et al. 2007). The components for each session in this standard treatment programme are presented in Table 2.

Oral hygiene instructions

The different oral cleaning devices were recommended on an individual basis in both groups. A soft toothbrush (Swedish brand TePe, Malmö, Sweden) was used for instruction of toothbrushing techniques. The participants in both groups were informed that a powered toothbrush with a small round brush and rotation oscillation movement was likely to be more effective than a manual toothbrush (SBU 2004, Robinson et al. 2005). Subjects who used a power toothbrush were encouraged to continue to use it and to bring the toothbrush to the clinic for individual instructions.

The decision on which inter-dental cleaning aids were most appropriate was dependent on the size of the inter-dental space and the morphology of the proximal tooth surfaces. *Dental floss* (dentotape, Johnson & Johnson, Sollentuna, Sweden) was recommended in a narrow inter-dental space and in the maxilla anterior teeth with intact papillae. *Triangular woodsticks* (TePe and Stim-u-dent, Johnson & Johnson) of three various dimensions were recommended in an open inter-dental space. For wide inter-dental spaces, inter-dental brushes with a handle (TePe and Doft, Östhammar, Sweden) were recommended. However, the aim was to choose as few cleaning aids as possible and not more than three aids besides the toothbrush, as patients tend to stop using oral hygiene cleaning aids if too many are recommended (Johansson et al. 1984). The thick woodstick in combination with one or two inter-dental brushes, 0.8 mm or larger, was the most common recommendation. All necessary

Table 1. Components in the individually tailored oral health education programme and clinical strategies at each session

Sessions	Components in the experimental intervention
	1. Initiation and establishment
1	Interview
2	Formulations of the most important long-term goals to fulfil in relation to oral heath.
	2. Analysis of oral hygiene habits
1	Frequency of behaviour
All sessions	Present oral hygiene status discussed and explores motivation for using various oral-cleaning aids
All sessions if necessary	3. Practice of manual dexterity
All sessions	4. Individual goals for oral hygiene behaviour
1–5	5. Continuous self-monitoring
3,4, or 5	6. Generalization of behaviour
Last session in the initial treatment and during maintenance	7. Prevention of relapse High-risk situations are identified and problem-solving strategies for how to handle those situations are discussed.

Table 2. Components of the standard treatment programme at each session

Sessions	Components in the control intervention
1	• Periodontal status is demonstrated and discussed. • Structured information is given about the periodontal disease, its consequences, the role of careful and correct brushing twice a day, and inter-dental cleaning once a day. • Oral hygiene instructions after use of disclosing solution. • The dental hygienist decides and gives prescriptions on which oral hygiene aids the subjects should use and encourages the patient to do inter-dental cleaning before toothbrushing, preferably in the evening. • The subjects are asked to demonstrate and practice the cleaning technique in their own mouth. • The subjects are informed their own engagement is crucial for successful treatment outcome.
Second and following sessions	• The oral hygiene status is checked with a disclosure solution. • New instructions and adjustments of aids and technique are discussed and demonstrated if necessary. • New information is given if the dental hygienist considers it necessary or if the subjects ask questions about periodontal disease or oral hygiene.

oral hygiene aids were provided, with the exception of power toothbrushes.

Non-surgical treatment and supportive periodontal care programme

Non-surgical root surface debridement was integrated into both programmes and undertaken during the initial dental hygiene treatment (visits one to five), mainly performed with hand instruments (LM® Gracys curette of five various designs and LM® Svärdström 1/3 and 2/4). There was some supplementary scaling after the 3-month follow-up and during the supportive maintenance care. At each session for both groups, the teeth were cleaned with polishing paste AV 170, and with flossing on proximal surfaces.

For both groups, supportive maintenance care was scheduled every third month after the initial dental hygiene treatment, i.e. 3 and 6 months after the 3-month follow-up. The supportive maintenance care sessions included checking oral hygiene status with disclosure solutions, and if necessary, re-instruction. For the experimental group these sessions included relapse prevention procedures and, when needed new goals for oral hygiene practise were discussed.

Treatment integrity

To increase the possibility that the treatment was implemented as intended, several strategies were applied (Perepletchikova & Kazdin 2005). Video recording of a session chosen at random verified that the content of the intervention in both groups corresponded with the study protocol. Data were collected to estimate the extent to which participants in the experimental group formulated long-term goals and the goals for oral hygiene practice, and completed the diary. The working sheets from the experimental group revealed that all participants formulated long-term and intermediate goals (action plans) and 47 out of 56 (84%) completed the diary in accordance with the study protocol. Data from a questionnaire, covering questions about the content of the both interventions, revealed that over 90% of the participants in the experimental group claimed they had formulated goals for oral hygiene procedures in writing, completed the diary, and formulated long-term goals. In the control group, almost all reported that no goal had been set and that no diary was used. The above data indicated that both programmes were implemented in accordance with the instructions.

Statistical Analyses

All statistical analyses were performed with SPSS software package (SPSS for Windows, version 15.0, SPSS Inc., Chicago, IL, USA). All participants were analysed in the group to which they were randomized. Complete baseline data were available for all randomized participants in both groups. An intention-to-treat analysis was applied where the attrition rates were imputed with a linear interpolation imputation method (according to SPSS 15.0) for GI and PlI data, and with the method of last value carried forward for oral hygiene behaviour (Twisk & de Wente 2002). Data for participant rating of global improvement and treatment satisfaction per protocol analyses are presented, including all participants who completed the questionnaire at the 12-month follow-up.

The mean values, standard deviations (SD), confidence intervals, and frequency distributions are given. The main outcome variables of GI and the secondary outcome variables of PlI were analysed with separate 2 (experimental group/control group) $\times$ 3 (baseline/3-month post-treatment/1-year follow-up) repeated measures analyses of variance (ANOVA repeated measure). The mean gain-score differences in GI and PlI between baseline and at the 3-month follow-up (post-treatment), between 3- and 12-month follow-up (maintenance period), and between baseline and 12-month follow-up (study period) were analysed by the Independent groups *t*-test. As multiple comparisons were made, a Bonferroni correction of the significant level was used in order to protect against type I errors (Engstrand & Olsson 2003).

The self-reported oral hygiene habits and satisfaction with the treatment were described and analysed by cross-tabulation and χ^2 tests. An α level of 0.05 or below was considered as statistically significant.

The study (Dnr 2005:314) was approved by the Ethics Committee of Uppsala University, Sweden.

Results

Attrition

One hundred and thirteen subjects were randomly allocated to participate in the study, 57 to an experimental group and 56 to a control group (See also Fig. 1). Six participants (four women and two men) dropped out during the study period. In the experimental group, one participant discontinued treatment before the intervention started due to economic reasons and a further two were lost at the 3-month follow-up; one became seriously ill and one moved temporarily from the county, but came back into the study at the 12-month follow-up. Another two participants dropped out between the 3- and the 12-month follow-up. In the control group, one participant discontinued treatment.

Subject characteristics at baseline

The baseline characteristics of the 113 participants receiving the individually tailored oral health educational programme or standard treatment are displayed in Table 3. Randomization was successful, as there was no statistically significant difference in the demographic variables or background characteristics between the groups (*p*-value not shown in tables).

Treatment time

In the experimental group, the median number of sessions for the intervention and scaling treatment was 5 (quartile deviation 4–5) up to the 3-month follow-up, and 9 (quartile deviation 8–9) when maintenance care was included up to the 12-month follow-up. In the control group, the median number of sessions was 4 (quartile deviation 3–5), and when the maintenance care was included, the median number of sessions was 8 (quartile deviation 8–9). Appointment time was approximately 60 min. for each session up to the 3-month follow-up, and approximately 45 min. for the maintenance period. In the experimental group, an extra 10 min. was needed for the first two sessions.

Treatment effect on gingival status

The 2×3 ANOVA repeated measures showed a significant time $\times$ group interaction for global GI, $F(2, 222) = 29.5$, $p < 0.001$, and for proximal GI, $F(2, 222) = 47.9$, $p < 0.001$, demonstrating that the groups developed differently over time, in favor of the experimental group. Post hoc analysis showed statistically significant gain-score differences between both baseline and the 3-month follow-up (global GI, $p < 0.001$; proxi-

Table 3. Baseline characteristics of the participants in the experimental and control group

	Experimental ($n = 57$)	Control ($n = 56$)
Mean age	52.4 (8.4)	50.1 (10.3)
Cigarette smokers	24 (42.1%)	20 (35.7%)
Gender		
Female	32 (56.1%)	28 (50.0%)
Male	25 (43.9%)	28 (50.0%)
Marital status		
Married or cohabitants	45 (78.9%)	40 (71.4%)
Single	12 (21.1%)	16 (28.6%)
Education		
Elementary school	14 (24.6%)	13 (23.2%)
High school	21 (36.8%)	23 (41.1%)
University	22 (38.6%)	19 (33.9%)
Ethnicity		
Swedish	46 (80.7%)	50 (89.3%)
Other	11 (19.3%)	6 (10.7%)
Previous visits to dentist		
Once a year	37 (64.9%)	37 (66.1%)
Every second year	10 (17.5%)	10 (17.9%)
At irregular intervals	10 (17.6%)	9 (16.0%)
Previous visits to dental hygienist		
Several times per year	20 (35.1%)	20 (35.7%)
Once a year	11 (19.3%)	21 (37.5%)
At irregular intervals	25 (43.9%)	15 (26.8%)
Number of teeth		
Baseline	25.3 (3.9)	25.0 (4.6)
At the start of non-surgical treatment	23.3 (4.0)	23.2 (4.6)

When numbers in columns do not equal *n* or 100%, there is an internal drop out in background data. For mean age and number of teeth standard deviation is presented.

mal GI, $p<0.001$), and baseline and the 12-month follow-up (global GI, $p<0.001$; proximal GI, $p<0.001$), in favour of the experimental group. There was no statistically significant gain-score difference between the 3- and the 12-month follow-up, i.e. both groups retained the achieved gingival standard during the maintenance period. The mean values, standard deviations, and mean gain-score differences between baseline and 3-month follow-up (post-treatment), 3- and 12-month follow-up (maintenance period), baseline and 12-month follow-up (study period) are given in Table 4.

For the experimental group, the reduction in global GI up to the 12-month follow-up was 77% and the corresponding reduction in the control group was 46%. For proximal GI the reduction was 75% in the experimental group and 39% in the control group.

Treatment effect on oral hygiene

The 2 × 3 ANOVA repeated measures test showed a significant time × group interaction, of $F(2, 222) = 8.91$, $p<0.001$ for Global PlI, and $F(2, 222) = 14.0$, $p<0.001$ for Proximal PlI, demonstrating that the groups developed differently over time in favour of the experimental group. Post hoc analysis showed significant gain-score differences in favour of the experimental group between both baseline to 3-month follow-up ($p = 0.003$), and baseline to 12-month follow-up ($p<0.001$). There was no significant gain-score difference between the 3- and the 12-month follow-up for global PlI, i.e. both groups retained the achieved oral hygiene standard. For proximal PlI, there were significant differences between all three intervals, i.e. baseline to 3-month ($p = 0.001$), 3–12-month ($p = 0.013$) and baseline to 12-month follow-up ($p<0.001$): the experimental group had a larger plaque reduction than the control group. The mean values, standard deviations, and mean gain-score differences between baseline and the 3-month follow-up (post-treatment), and 3- and 12-month follow-up (maintenance period), and baseline and 12-month follow-up (study period) are given in Table 5.

Oral hygiene behaviour

Approximately 90% of the participants in both groups reported toothbrushing twice a day at baseline, and the frequency was consistent throughout the study period.

At baseline, 26 (46%) of the participants in the experimental group and 21 (38%) in the control group reported daily inter-dental cleaning. After dental hygiene treatment at the 3-month follow-up, both groups increased use of inter-dental cleaning: 45 (79%) of participants in the experimental group and 37 (67 %) in the control group reported inter-dental cleaning once a day. There were no statistically significant differences between the groups either at baseline ($\chi^2(1, n = 113) = 0.76$, $p = 0.382$) or at the 3-month follow-up [$\chi^2(1, n = 113) = 1.94$, $p = 0.163$]. More participants in the experimental group (45 (79%) reported daily inter-dental cleaning than in the control group (33 (59%) at the 12-month follow-up [$\chi^2(1, n = 107) = 5.29$, $p = 0.021$].

Participant rating of global improvement and treatment satisfaction

A higher proportion of individuals in the experimental group estimated that they were able to perform oral self-care much better after treatment (12-month follow-up) than in the control group [χ^2(df 1, $n = 105) = 5.02$, $p = 0.024$], although both groups estimated better performance (Table 6). Both groups indicated that they were much more or more satisfied with their oral health after dental hygiene treatment than before treatment: there were no significant differences between the two groups [χ^2(df 2, $n = 105) = 2.69$, $p = 0.233$]. More participants in the experimental group reported daily compliance with the skills attained during the treatment [χ^2(df 2, $n = 105) = 8.76$, $p = 0.025$], and they estimated a significantly higher likelihood to maintain new habits than individuals in the control group did [χ^2(df 1, $n = 106) = 5.97$, $p = 0.015$]. The analysis of satisfaction with care provided by the dental hygienist revealed no significant differences between the groups [χ^2(df 1, $n = 105) = 1.23$, $p = 0.266$]. Most participants, irrespective of groups, considered the treatment to be valuable.

Discussion

An individually tailored oral health educational programme was more effective for achieving proper long-term oral hygiene self-care behaviour and resulted

Table 4. Global GI and proximal GI at baseline, 3- and 12-months follow-up

	Mean (SD)								
	Baseline	3-month follow-up	12-month follow-up	Baseline – 3-month mean gain score difference (CI)	*p*-value	3–12-month mean gain score difference (CI)	*p*-value	Baseline – 12-month mean gain score difference (CI)	*p*-value
GI global									
Exp	0.92 (0.28)	0.27 (0.14)*	0.21 (0.16)*	0.27 (0.14–0.41)	<0.001	0.03 (− 0.03–0.09)	ns	0.27 (0.16–0.39)	<0.001
Ctr	0.92 (0.23)	0.52 (0.20)	0.50 (0.17)						
GI proximal									
Exp	1.14 (0.27)	0.37 (0.17)*	0.28 (0.20)*	0.36 (0.22–0.50)	<0.001	0.03 (− 0.13–0.06)	ns	0.40 (0.27–0.53)	<0.001
Ctr	1.13 (0.23)	0.72 (0.21)	0.69 (0.20)						

*Independent groups *t*-test at the 3-month follow-up ($t = 8.20$, $p < 0.001$; $t = 9.50$, $p < 0.001$) and at 12-month follow-up ($t = 9.61$, $p < 0.001$; $t = 10.7$, $p < 0.001$).

ns, not significant; Exp, Experimental group ($n = 57$); Ctr, control group ($n = 56$); SD, standard deviation; CI, 99.2% confidence interval; GI, gingival index (0–2), low scores indicate low gingival inflammation.

Table 5. Plaque indices for full-mouth (global) and interproximal surfaces at baseline 3-, and 12-months follow-up

	Mean (SD)								
	Baseline	3-month follow-up	12-month follow-up	Baseline – 3-month mean gain score difference (CI)	*p*-value	3–12 month mean gain score difference (CI)	*p*-value	Baseline – 12-month mean gain score difference (CI)	*p*-value
Global PlI									
Exp	0.74 (0.34)	0.17 (0.11)*	0.14 (0.13)*	0.17 (0.02–0.32)	0.003	0.02 (− 0.04–0.09)	ns	0.16 (0.03–0.30)	<0.001
Ctr	0.73 (0.31)	0.32 (0.22)	0.31 (0.16)						
Proximal PlI									
Exp	1.01 (0.37)	0.29 (0.18)*	0.23 (0.19)*	0.22 (0.04; 0.40)	0.001	0.08 (0.00–0.16)	0.013	0.26 (0.10–0.43)	<0.001
Ctr	0.99 (0.35)	0.48 (0.28)	0.49 (0.22)						

*Independent groups *t*-test at the 3-month follow-up ($t = 4.36$, $p < 0.001$; $t = 4.26$, $p < 0.001$) and at 12-month follow-up ($t = 6.07$, $p < 0.001$; $t = 6.87$, $p < 0.001$).

ns, not significant; Exp, Experimental group $n = 57$; Ctr, control group $n = 56$; SD, standard deviation; CI, 99.2% confidence interval; Pli, Plaque Index (0–2), low score indicate high standard of oral hygiene performance.

in a larger reduction in gingival inflammation than standard treatment. The differences between groups remained throughout the 1 year study period. Hence, the hypothesis for the study was confirmed.

The largest reduction in gingivitis and the largest improvement in oral hygiene were observed at the 3-month follow-up for both groups, i.e. immediately after the intervention was introduced and scaling treatment was performed. The improvement was maintained at almost the same level up to the 12-month follow-up. There was a marked difference between the groups, especially the experimental group, in the reduction of GI. These findings were in line with a review by Renz et al. (2007), who also reported a higher decreased gingival bleeding for the cognitive/behavioural intervention group.

Plaque accumulation yields a recurrence of periodontal disease and dentitions under effective plaque control maintain periodontal stability (Rosling 1983, Axelsson et al. 2004). However, the level of plaque control for maintaining healthy gingival tissue is not clearly defined, although it is suggested that a total plaque score (all sites) of around 25% might be tolerable for most individuals with periodontal disease (Lang & Tonetti 2003, Htoon et al. 2007). In the present study, both groups reached a low level of total plaque scores and were even lower compared with the plaque level reported in Renz et al. (2007). The present results agreed with other behavioural intervention studies in patients with periodontal disease (Philippott et al. 2005, Jönsson et al. 2006, Renz et al. 2007) and strengthened the hypothesis that interventions based on a psychological approach are more effective for oral hygiene behavioural change than a standard treatment. Another important matter to consider when dental index scores are used to evaluate short- and long-term oral hygiene behaviour is that the total index score for both GI and PlI is only an approximation of the total dentition. Therefore, the index could conceal sites or areas in the mouth with insufficient cleaning. If these sites correlate with sites where periodontal problems are most pronounced, it may result in poorer healing of the periodontal pocket and a smaller reduction of gingival inflammation (Tomasi et al. 2007). In this study, the differences between groups for both GI and PlI were most pronounced for the proximal sites. These differences were further validated by participants' global rating of inter-dental cleaning, use of skills learned during the treatment and maintenance of behavioural change. The individually tailored oral health educational programme seemed to have a higher impact on the frequency of daily inter-dental cleaning, daily use of learned skills and a higher certainty to maintain the attained level of behaviour change than did the standard treatment programme.

Table 6. Participants overall evaluation of Dental Hygiene treatment at 12-months follow-up

	Experimental group ($n = 50$)	Control group ($n = 55$)
Performance of oral hygiene		
Much better	45 (90%)	40 (73%)
Better	5 (10%)	15 (27%)
Satisfaction with oral heath		
Much more satisfied	35 (70%)	31 (56%)
More satisfied	15 (30%)	23 (42%)
No difference	0 (0%)	1 (2%)
Compliance to skills obtained during treatment		
Daily	44 (88%)	37 (67%)
Several times a week	4 (8%)	17 (31%)
Some times per week	2 (4%)	1 (2%)
Likelihood to maintain habits		
Very likely	46 (87%)	39 (71%)
Likely	5 (9%)	16 (29%)
Satisfaction with dental hygienist treatment		
Very satisfied	44 (88%)	44 (80%)
Satisfied	6 (12%)	11 (20%)
Treatment worth the time and treatment costs		
Yes, absolutely	43 (86%)	47 (85%)
Yes, to some extent	7 (14%)	8 (15%)

n = number of participants in each group who returned the questionnaire. When numbers in columns do not equal n or 100%, there is internal dropout in the questionnaire. Only the scale possibilities in each item that the participants responded to are presented.

The tailoring approach used for the experimental group was in contrast to the targeting of treatment (Kreuter & Skinner 2000) used for the control group. Targeting is designed to suit all people with a specific diagnosis, for example periodontal patients. In a targeting approach, health education, based on the assumption of the best treatment approach for a person with periodontal disease, emanates from the dental hygienist's perspective. This contrasts to a tailoring approach, where the individual's perspective is considered as the primary aspect, i.e. the individual's personal goals for oral health and treatment and the context in which the individual exists. Both educational models in this study appear to have had a positive impact on the patients, as almost all participants were very satisfied with the dental hygiene treatment and reported that the treatment was worth the time and treatment costs. There was a small difference between the two groups in terms of the time required for the treatment, with more time required for the experimental group.

Several precautions were taken to increase treatment integrity and internal validity. All data confirmed that the objectives were fulfilled by the two interventions and the interventions followed the study protocol. Both groups noted improvements and the differences between and within groups were similar for both dental hygienists. The person who performed all clinical measurements was blinded to group allocation, and intra-observer judgement showed good reliability, which strengthened the internal validity. The power analyses revealed that about 150 participants were required for the study. Although the desired number of participants was not reached further inclusion was discontinued for two reasons. First, the examiner was unable to participate in the whole process of the requirement and there were difficulties in introducing a new examiner to the study with short notice, and second, the original power analysis was based on an intervention judged as being less effective than the present one. Therefore, the effect size was probably underestimated.

Even if the care-provider requires understanding and training in cognitive/behavioural methods and must learn and practice the MI technique, this study highlighted that it is possible to use individually tailored oral health education programmes in a dental clinic setting by a dental hygienist. The population consisted of patients with periodontal disease who were referred to a specialist clinic. However, a reasonable assumption is that the programme could be applied in other similar clinical settings, in general dental care and in other dental fields where the patient's active role is of crucial importance for the success of the treatment. To confirm the external validity of the programme, it is necessary to test the programme with different care-providers and in different clinical settings.

In conclusion, an individually tailored oral health educational programme based on an integrated cognitive/behavioural and oral health approach is more effective than the standard treatment for achieving proper long-term oral hygiene behaviour resulting in reduced plaque and gingivitis, specifically interproximally.

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Supporting Information

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Table S1. Supporting information in accordance with the CONSORT Statement 2001 checklist used in reporting randomized trials.

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Clinical Relevance

Scientific rationale for study: Cognitive behavioural strategies claim to increase adherence to oral hygiene practice, but no previous study has introduced an individually tailored oral health educational programme adapted to individual goals and problems integrated within non-surgical periodontal treatment.

Principal findings: The individually tailored oral health educational programme was effective. Participants reached a higher level of oral hygiene performance and improved gingival health more than participants receiving standard treatment. The differences were most pronounced for interproximal sites.

Practical implications: Cognitive behavioural strategies can be performed by trained dental hygienists in a regular clinical setting. Patients receiving an individually tailored oral health educational programme ought to be better off for future oral self-care and the need for maintenance care. However, the long-term cost-effectiveness of the intervention needs further analysis within more comprehensive health economic analyses.