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ORIGINAL ARTICLE

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Does professional preventive care benefit from additional subgingival irrigation?

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Abstract The effect of an oral irrigator (Water Pik, Intersanté) with a subgingival tip (Pik Pocket Subgingival Tip, Intersanté) in the reduction of gingivitis was investigated in a single-blind three-group study involving 45 volunteers (age 46.2±10.2). All volunteers (inclusion criteria: gingivitis or a superficial periodontitis) were examined and underwent professional tooth cleaning at the first appointment. They were then randomly distributed in three groups: one group used the irrigator with the subgingival tip once daily with just tap water, in addition to their regular oral hygiene; another group also used an herbal-based mouth rinse (Parodontax, GlaxoSmithkline) in the water of the irrigator; a third group did not use an irrigator or any irrigant and therefore served as control. All groups received professional oral care education at each appointment. The investigation period was 3 months. At baseline and after 4, 8, and 12 weeks, the plaque index (PI, scores 0–5), gingival index (GI, scores 0–3), bleeding index (BI scores 0–5), and sulcus fluid flow rate (SFFR, Periotron 6000) at the Ramfjord teeth were scored. At baseline and after 3 months, the probing depth (millimeters) was measured at six surfaces of all teeth. A significant reduction in BI, PI, GI, probing depth, and SFFR was observed within 3 months. With all volunteers, however, there was no statistically significant difference ($p \geq 0.05$, Wilcoxon-test, SAS 6.04) between the three groups at any time. The additional use of the Water Pik irrigator with the Pik Pocket subgingival irrigation device with or without an herbal mouth rinse showed no clinical benefit over professional education in oral hygiene alone.

Keywords Dental plaque · Irrigator · Mouthwashes · Parodontax · Periodontitis · Subgingival irrigation

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Introduction

To maintain oral health, mechanical aids such as toothbrushes, interdental brushes, dental floss, toothpicks and chemical aids such as toothpastes and mouthwashes have become a standard in oral care over time. In recent decades, different powered devices such as power toothbrushes and oral irrigators have appeared. In the meantime, dozens of studies have investigated the potentially positive effects of oral irrigators [3, 6, 14, 16, 26, 28, 48, 66, 73, 76]. In the 1980s, it was verified that the irrigation of pockets had a temporary effect in terms of reducing gingival inflammation [7, 24, 68, 78]. Oral irrigators are described as an appropriate instrument for dental plaque removal. But in fact, oral irrigators only rinse away materia alba, food debris and loose parts of dental plaque [23]. None of today's irrigation devices are able to remove significantly more plaque adhering to teeth [25, 30] than regular oral hygiene does without powered devices. Although the use of oral irrigation devices has no significant effect on removing plaque, when a toothbrush and floss are used thoroughly, various studies show a reduction of gingival inflammation. In 1989, the American Dental Association (ADA) confirmed that the use of oral irrigators can have a therapeutic effect on the periodontal tissues. The patient's acceptance of such powered aids has been confirmed in literature. Walsh et al. [74] stated in their clinical studies that the use of oral irrigators by patients was convenient and easy. Newman [47] could prove that the use of an oral irrigator in addition to regular oral hygiene improved the gingival and the bleeding indices significantly.

In addition, oral irrigators were used to deliver antimicrobial agents into the pocket [34]. Wennström et al. [78] investigated, microbiologically and radiologically, whether the use of chlorhexidine or hydrogen peroxide as a professional irrigation had an effect on periodontal pockets. In a clinical study, Aziz-Gandour and Newman [5] compared a regular oral hygiene regime with oral hygiene plus chlorhexidine (0.02%) or metronidazole (0.05%) applied with an oral irrigator. They discovered

that oral health with regard to plaque, bleeding on probing and gingival index improved significantly. Brownstein et al. [13] saw the use of an oral irrigator in combination with chlorhexidine irrigation (0.06%) as a therapeutic instrument in gingivitis therapy, especially in regard to bleeding on probing. According to Walsh et al. [74, 75], a chlorhexidine solution (0.2%) has a more bactericidal effect when applied with an oral irrigator than if used as a mouthwash only. Parsons et al. [53] recommend an oral irrigator using a sanguinaria extract. In comparison to sanguinaria as a mouthwash, or to an irrigator with water only, they showed that gingivitis could be reduced by 73.3% (irrigator with sanguinaria) and 68.7% (irrigator with water).

Southard [69] investigated the different effects of a sanguinaria mouthwash as a mouthwash, and as a supragingival irrigation delivered with oral irrigator, respectively, in terms of the inhibition of new formation of plaque. Both the use of sanguinaria as a mouthwash and the supragingival irrigation of dilute sanguinaria resulted in significantly less plaque growth and a significantly pronounced reduction of gingivitis when compared with supragingival irrigation with a placebo compound.

Further, efforts were made to deliver irrigants into the periodontal pocket, using specially designed applicator tips, for example, in peri-implant maintenance [21]. Boyd et al. [8] compared the depths of penetration of a special canula shaped irrigator tip to a standard tip and to mouthwash, while Itic and Serfaty [27] compared the effectiveness of a special tip to that of an irrigation performed with a syringe. In doing so, they deduced that the professionally performed irrigation with the tested special irrigator tip was more effective regarding plaque index, sulcus fluid flow rate and probing depths, though none of the tested methods represented appropriate periodontal therapy. Therefore, delivery application tips for oral irrigators, directing the irrigant towards the location, where it is needed most—in the periodontal pocket—might be of interest as an additional means in professional prevention and guidance in oral home care.

Aim of this study

The aim of this study was to evaluate the effectiveness of an oral irrigator with a subgingival tip in improving oral parameters within a *professional* oral hygiene program. Additionally, the effect of an herbal mouthwash as an irrigant in the irrigator was investigated.

Materials and methods

Subjects

The study involved the selection of 45 subjects (mean age 46.4± 10.2 years, no dental professionals, no dental students) in good general health, with at least 20 teeth and with probing depths between 3–5 mm. Medical histories were reviewed. Subjects with valvular defects or endocarditis were excluded because bacteremia has been shown to be associated with the use of oral irrigation devices [20, 62]. Furthermore, subjects reporting use of anti-inflammatories, antithrombolytics or acetylsalicylic acid were excluded, due to potential bleeding complications. Further exclusions were due to medication histories including nifedipine, phenytoine, cyclosporine, psychotropics, anorexiants and antibiotics, because of their potential influence on the mucosa and oral tissues and a possible change of the composition of their dental plaque [61].

Study design

The volunteers were aware of their periodontal problems and consented to periodontal pre-treatment surgery (intensive oral hygiene instructions + control). Initially, every subject received a professional preventive care treatment, including individual instruction for optimized oral care at home, in an individualized treatment plan. The techniques were demonstrated and then practiced together with the instructor. All volunteers were informed about the causes and consequences of periodontal diseases while each subject's responsibility was emphasized. In addition, nutritional education was provided. At the end of this first appointment (baseline), all supra-gingival tartar and the visible sub-gingival tartar as well as stains were removed in every subject to ensure ideal oral hygiene. All volunteers received a hand-held toothbrush (Oral B Advantage 35, Gilette Oral B, Boston, USA) and standard toothpaste (Elmex, GABA, Lörrach, Germany). All subjects were randomly assigned to one of three groups: one group was assigned an irrigator with 1 ml Parodontax mouthwash adjuvant to the water of the irrigator, and individualized instructions for optimum care; another group was assigned the oral irrigator as well in addition to their personalized oral care regimen, but used tap water without the Parodontax irrigant; the third group was assigned only hand-held toothbrushes. The volunteers of all three groups were encouraged to floss daily, and to follow their individualized instructions for optimum care.

Oral irrigator and irrigant

The irrigation devices included a commercially available irrigation system; Water Pik (Intersanté GmbH, Bensheim, Germany) and the accompanying tip, Pik Pocket-Irrigator Tip (Fig. 1, Intersanté GmbH). The irrigator has a detachable water tank (300 ml), and the tip produces 1,200 pulses per minute. According to the manufacturer, the tip will not injure gingival tissue. The Pik Pocket Irrigator Tip is specially designed with an elastic, cone-shaped silicone tip from which the irrigant emerges. Ten drops of Parodontax mouthwash (GlaxoSmithKline Consumer Healthcare, Weybridge,

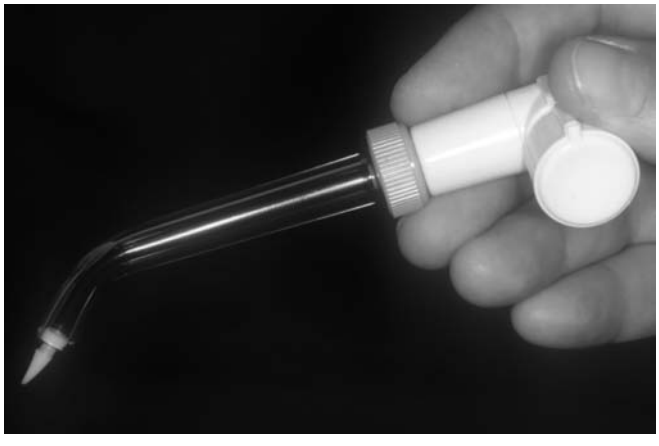

Fig. 1 Pik Pocket-Irrigator tip, as used in the clinical trial for subgingival irrigation

UK), equaling 1 ml, were added to the water tank. The ingredients of the mouthwash (according to the manufacturer's brochure) are: tincture of chamomile, tincture of myrrh, tincture of rhatany, extract of echinacea, sage oil, peppermint oil, sodium hydrogen-carbonate, sodium fluoro-phosphate, propylene glycol and water.

Clinical parameters

To determine the degree of periodontal inflammation, sulcus fluid was collected at the Ramfjord teeth (teeth no. 16, 21, 24, 36, 31). There, small paper strips were inserted into the periodontal margin for 10 s and the quantity of sulcus fluid was measured with the Periotron 6000 (Pro Flow Incorporated, Amityville, New York). Scores from 0 to 10 represented a healthy gingiva, from 11 to 20 a mildly inflamed gingiva, 21 to 40 a gingivitis, and 41 and higher a severe gingival or periodontal inflammation.

To evaluate the patients' general oral hygiene, the Plaque Index [57] was used. Plaque was stained (5% erythrosin solution, Plaviso, Voco, Cuxhaven, Germany; application by means of a foam-pellet onto the air-dried tooth surfaces) and measured. To determine the degree of inflammation of gingival soft tissues, the Gingival Index was taken [37,39]. Likewise for the determination of inflammation, the Bleeding Index [45] was documented. Pocket depth was measured at the baseline investigation and after 4 weeks at the final examination.

Re-evaluation

The volunteers were re-examined and re-motivated after 4 and 8 weeks. Three months after baseline, a final examination was conducted.

Statistical analysis

Statistical evaluation was done in cooperation with the Institute for Medical Statistics and documentation performed using the statistical program, SAS. For all indices, median values and percentiles (25% percentile = Q1, 75% percentile = Q3) were calculated. Results were calculated for each of four appointments and for each group separately and compared to each other. The Kruskal-Wallis test and the Wilcoxon Test were used.

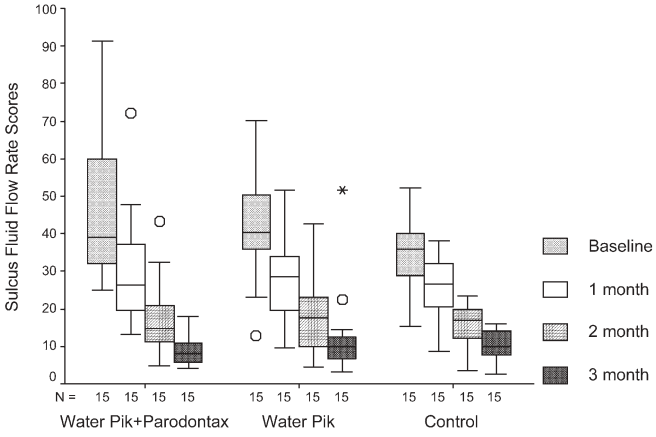

Fig. 2 Box plot drawing of the decrease in sulcus fluid flow rate (SFFR) versus the observation period of 3 months for all three groups investigated

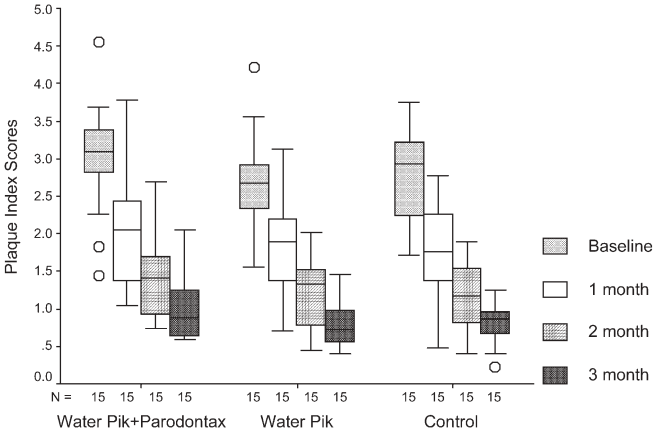

Fig. 3 Box plot drawing of the decrease in observed Plaque Index (PI) versus the observation period of 3 months for all three groups investigated

Results

In the group where the subjects used the irrigator together with the Parodontax mouth rinse, the median sulcus fluid flow rate was reduced from 39.2 (Q1:31.0; Q3:60.6) to 8.2 (Q1:5.8; Q3:11.8); while in the group using the irrigator with tap water, the sulcus fluid scores decreased from a median of 40.5 (Q1:34.3; Q3:53.5) to 9.8 (Q1:6.3; Q3:12.8). In the control group, which used no irrigator and no mouthrinse, the median sulcus fluid flow rate was reduced from 35.8 (Q1:28.7; Q3:40.3) to 10 (Q1:6.8; Q3:14.3) (Fig. 2).

The median plaque index was reduced from 3.1 (Q1:2.8; Q3:3.5) at baseline to 0.9 (Q1:0.6; Q3:1.3) after 12 weeks in the irrigator plus mouthwash group, from 2.7 (Q1:2.1; Q3:2.9) to 0.7 (Q1:0.5; Q3 0.9) in the irrigator plus tap-water group, and from 2.9 (Q1:2.2; Q3:3.3) to 0.9 (Q1:0.7; Q3:1) in the control group (Fig. 3).

The Gingival Index was reduced in all three groups to almost zero (Fig. 4). Using the irrigator plus the mouthwash resulted in a median reduction from 2.0 (Q1:2.0; Q3:2.3) to 0.0 (Q1 and Q3:0.0); the irrigator with tap water reduced the Gingival Index from 2.0 (Q1:2.0; Q3:2.0) to 0.0 (Q1 and Q3:0.0); and in the control-group, a reduction from 2.0 (Q1:2.0; Q3:2.1) to 0.0 (Q1:0.0; Q3:0.3) was documented.

The bleeding on probing index was reduced to almost zero in all three groups as well (Fig. 5). It was reduced from a median score of 2.3 (Q1:2.0; Q3:3.0) at baseline to 0.0 (Q1 and Q3:0.0) after 3 months in the group using the irrigator plus the mouthwash, from 2.0 (Q1:1.8; Q3:3.0) to 0.0 (Q1 and Q3 0.0) in the group that used the irrigator plus tap water, and from 2.0 (Q1:1.8; Q3:2.7) to 0.0 (Q1:0.0; Q3:0.1) in the control group.

Furthermore, the median probing depth was reduced in all three groups comparing baseline to fourth appointment: from 3.3 mm (Q1:2.9; Q3:3.6) at baseline to 2.0 mm (Q1:1.7; Q3:2.4) after 12 weeks in the irrigator plus mouthwash group, from 3.2 mm (Q1:2.8; Q3:3.6) to 2.1 mm (Q1:2.0; Q3:2.1) in the irrigator plus tap water group, and from 2.8 mm (Q1:2.5; Q3:3.5) to 2.0 mm (Q1:1.7; Q3:2.5) in the control group (Fig. 6).

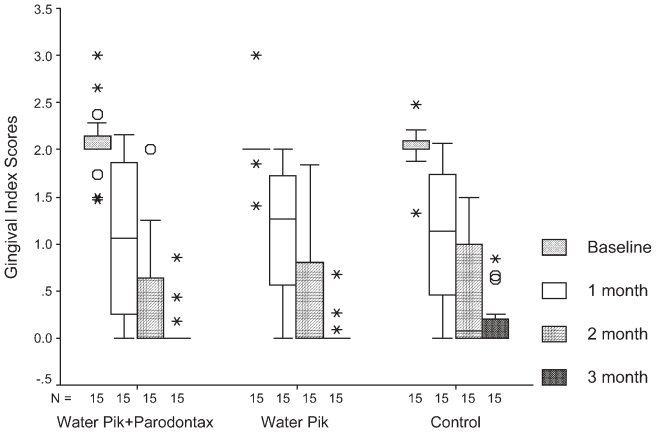

Fig. 4 Box plot drawing of the decrease in the Gingival Index (GI) versus the observation period of 3 months for all three groups investigated

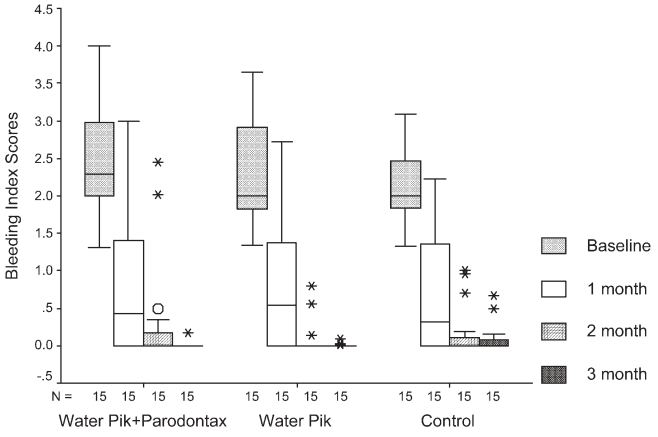

Fig. 5 Box plot drawing of the decrease in the Bleeding Index (BI) versus the observation period of 3 months for all three groups investigated

After 3 months, all three groups of subjects showed significant improvements in terms of inflammation, probing depths, and even plaque accumulation (p <0.005, Wilcoxon signed rank-test).

Comparing the three groups (Kruskal-Wallis-Test), no statistically significant differences were found. Accordingly, no significant results exist when comparing two groups (Wilcoxon Test). When comparing the irrigator group, which used the addition of Parodontax to the pure tap water group, the p values for the median Plaque Indices were 0.13, for the Gingiva Index 0.94, for the Sulcus Fluid Flow Rate 0.86, for the Bleeding Index p =0.93, and finally for Probing Depths 0.87. Comparing the other groups, no significant results could be determined either (p >0.1).

Discussion

In the present study, the additional use of an irrigator with tap water or an herbal irrigant was not able to improve the

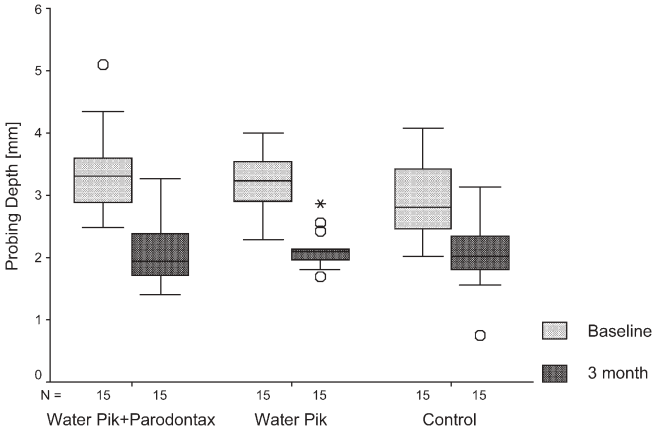

Fig. 6 Box plot drawing of the decrease in probing depth versus the observation period of 3 months for all three groups investigated

parameters investigated in well-instructed and motivated patients. This is in contrast to a comparable study [55], where the volunteers were not professionally instructed and motivated, and it emphasizes the superiority of individual instruction and training in oral home care and frequent education over additional ingredients and powered devices. Therefore, comprehensive oral hygiene instruction is important in order to achieve an overall reduction in periodontal pathogen bacteria [36] in a plaque- and calculus-free oral environment [12], but the individual situation of the patient and his or her manual skills have to be considered as well. The positive effect of these efforts is clearly demonstrated in the control group. A highly significant reduction in all parameters was investigated after 3 months. The improved probing depths can be explained by the general reduction of swelling of the gingival margin. Due to the fact that in this study, the additional subgingival irrigation had no effect, it cannot be recommended in cases where a patient is able to participate in preventive care.

Irrigation

The three different methods of oral irrigation, namely supragingival, marginal and subgingival irrigation, require differentiation [65]. The subgingival irrigation is mostly applied chair-side by dental professionals as an important means to treat periodontal diseases. Clinical trials prove the effectiveness of subgingival irrigation [79], though side effects from oral irrigators do exist. Several clinical studies [20, 66, 71, 73] showed a correlation between the use of oral irrigators and bacteremia.

Some oral irrigators feature a continuous, rather than a pulsating water jet [23], and depending on the particular model, devices with single or multi-jets are available. The difference between single and multi-jet devices has been investigated only in short time trials. Multi-jet irrigators seem to have a better cleaning effect in terms of plaque, whereas no differences concerning the gingiva could be

found [34]. Although the gingival margin can withstand pressures up to 1,400 kPa, the water pressure should not exceed 500 kPa for a therapeutic irrigation [56]. In order to avoid the improper use of the Water Pik, or any kind of trauma, the subjects in this trial were instructed by the examiner how to handle the irrigator and the irrigator tip properly, for example how to orient the irrigator tip at a 45° angle to the gingival margin, or the careful insertion of the tip into the periodontal pocket. The use of oral irrigators leads, in comparison to a toothbrush, to a vasoactive reaction of tissues followed by a higher amplitude of the volume pulse in the vessels of the interdental gingiva. Unfortunately, this effect lasts only about half an hour and is therefore of no therapeutic usefulness [43, 44, 45]. The irrigation with antimicrobial substances of periodontal pockets alone does not lead to persistent improvement [32, 79]. Periodic irrigations with chlorhexidine, tetracycline and hydrogen peroxide in untreated pockets results in a momentary reduction in the tendency to bleed, while it has no impact on probing depths or the loss of periodontal tissue [26, 67, 78, 79]. On the other hand, following periodontal surgery, the daily irrigation of pockets stabilizes and prolongs successful outcomes [72, 77]. In the present study, the additional use of a subgingival irrigation did not result in any additional improvement in the reduction of the identified indices. Possibly an irrigator used solely, without any kind of professional tooth cleaning, instruction and motivation, would produce significant impact, but this was not the subject of this study.

Mouthwashes

Antimicrobial agents are being used in dentistry to inhibit the formation of plaque and reduce gingivitis. In numerous trials, this effect could be proven. The damage to periodontal structures is predominantly caused by the inflammation induced by bacterial biofilms [38]. The existence of spirochetes and gram-negative organisms seems to correlate directly with the incidence of periodontal diseases [25, 36, 40, 83]. Mouthwashes with additional antimicrobial agents are able to reduce plaque in the oral cavity and therefore counteract inflammatory periodontal diseases [35]. The effectiveness of the chosen agent depends on its concentration in the pocket [33]. Another factor influencing the effect of mouthwash is the amount of agent, the duration of application, the type of carrier, and the pH and pK values [63]. It is also important that the applied agents have a specific affinity to the oral mucosa [64]. Nevertheless, there are many different agents being used in mouthwashes such as herbal agents, essential oils or bis-biguanides. Bis-biguanides, i.e., chlorhexidine, affect a wide range of bacteria and therefore are one of the most effective agents against pathogenic germs [2, 10, 19, 41, 49, 50]. Felo et al. [21] used the same Water Pik subgingival irrigating tip used in the present study in peri-implant maintenance. In contrast to Parodontax in the present study, they used 0.06% chlorhexidine as a mouthwash and as an adjunct in the irrigator. They concluded that use of diluted 0.06% chlorhexidine when used in a powered irrigator may be a valuable adjunct to oral health in patients with implants. Chaves et al. [15] found that 0.12% chlorhexidine as a mouthwash and as an adjuvant in an irrigator had a 30–35% decrease in mean Plaque Index, while manual toothbrushing and irrigation with water showed only a 12–16% decrease.

Many studies attest to the explicit reduction of plaque with the use of chlorhexidine, which is based on the interference of the agent in the bacterial carbohydrate metabolism [1, 11, 19, 49, 70]. Unfortunately, chlorhexidine is not free of side effects such as irritation of the mucosa, taste, glossopyrosis and staining of teeth, and is therefore not suitable for long-term use. It is a supplement for short-term and controlled application [1, 11, 19, 28, 30, 70].

Many studies report a plaque reduction with application of such essential oils as menthol, eucalypthol and thymol [9, 10, 49, 54], but all of the agents were diluted in alcohol solutions. Alcohol denatures bacterial cell walls. In vivo, this antimicrobial effect has not been verified. On the other hand, there are trials which prove the positive effect of essential oil mouthwashes. It has been shown that the use of a mouthwash with different essential oils altered the appearance of the cell surface of some oral bacteria and therefore leads to the conclusion that the effect is primarily based on the damage to the cell surface of certain microorganisms [31]. In one in vitro investigation, a mouthwash with essential oils had a significantly higher ability to eliminate oral microorganisms than an amine flouride-stannous fluoride mouthwash [52]. But it was proven that chlorhexidine was more effective in terms of repressing a new formation of plaque than essential oils [51]. Considering signs of gingival inflammation, essential oils seem to have a higher impact [4, 51].

Findings about herbal agents [46] such as sanguinaria are not uniform. Sanguinaria, an alkaloid, interferes with various enzymes, disturbs the glycolysis and thereby has an antimicrobial effect [2, 30, 81]. While some trials attest a plaque-reducing effect [54], others do not [2]. In the present clinical study, the outcomes (Plaque Index, Bleeding Index and Gingival Index) of the group using neither the mouthwash nor the irrigator were similar. Therefore, the reduction of plaque was probably accomplished by the use of floss, the interdental brushes, the new toothbrush and a more effective brushing technique.

Patients with gingivitis using the Parodontax toothpaste showed less plaque and had fewer signs of inflammation. The positive effect of the toothpaste was proven in clinical trials [59, 60, 84]. In another study, Parodontax Professional, applied over 2 weeks with a tray, reduced the Bleeding Index from 61.5 to 27.5% [18]. Comparable positive results were also shown in a clinical trial where Parodontax toothpaste and mouthwash were tested. All subjects suffered from a mild to severe gingivitis. It could be shown that the Parodontax ingredients were able to reduce both the microbial plaque formation and the inflammatory diseases of the gingival margin: the Bleeding

Index decreased from 70 to 28.5% [82]. A major advantage was the low percentage of negative side effects such as tooth staining and bad taste. This is proven in a trial from 1995 which concluded that Parodontax can be used even for long periods without major side effects [80].

Conclusion

A significant reduction in Sulcus Fluid Flow Rate, Plaque Index, Gingival Index, Bleeding Index, probing depth and before and after was observed in patients undergoing professional hygiene education prior to a periodontal surgery. There were, however, no statistically significant differences between the three groups at any time. The additional use of the Water Pik irrigator with the Pik Pocket subgingival irrigation device showed no clinical benefit over professional guidance in oral hygiene alone. On the other hand, the additional use of the Water Pik irrigator with the Pik Pocket subgingival irrigation device may be of benefit in patients who have not received professional patient education. The chair-side application of subgingival irrigations prior to or even within periodontal surgery is reasonable, but there is no benefit for individual home use in patients personally instructed and trained in oral care and who are re-evaluated and re-motivated frequently. Nevertheless, mouthwashes seem to be suitable in treating gingivitis in addition to daily regular oral hygiene and are therefore not superfluous for additional prophylaxis; however, mouthwashes are not able to replace or add to a proper mechanical cleaning.

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