Position Paper

The Role of Supra- and Subgingival Irrigation in the Treatment of Periodontal Diseases*

This position paper addresses the role of supra- and subgingival irrigation in the treatment of periodontal diseases. It was prepared by the Committee on Research, Science and Therapy of the American Academy of Periodontology. The document is divided into two portions, consisting of supragingival irrigation and subgingival irrigation. In their respective segments, these treatment techniques are assessed as monotherapies and as adjuncts to conventional treatment. The conclusions drawn in this paper represent the position of the American Academy of Periodontology regarding irrigation therapy in the treatment of periodontal diseases. *J Periodontol 2005;76:2015-2027.*

Periodontal diseases are infections of the periodontium. These diseases are induced by a variety of organisms that colonize and proliferate supra- and subgingivally in susceptible individuals. Conceptually, supra- and subgingival irrigation have the potential to be used by therapists and patients to help suppress bacterial etiologic agents. The biologic rationale for performing supra- and subgingival irrigation is to non-specifically reduce microbial deposits that may induce periodontal diseases. The primary objective of supragingival irrigation is to flush away bacteria coronal to the gingival margin, thereby diminishing the potential of developing gingivitis or decreasing existing gingival inflammation. In contrast, subgingival irrigation attempts to directly reduce the pocket microflora to prevent initiation of periodontal diseases or to facilitate their reduction. However, both treatment methods have limitations. This paper was written to clarify the benefits and limitations of supra- and subgingival irrigation (lavage) in the treatment of periodontal diseases.

SUPRAGINGIVAL IRRIGATION

Hydrokinetics and Irrigation Forces

Devices used for supragingival lavage usually provide a pulsating stream of water that incorporates a compression and interpulse decompression phase. A continuous flow of water causes constant tissue compression and impedes escape of contaminants. Therefore, a decompression phase is included to facilitate displacement of debris and bacteria.[1] Supragingival irrigation forces of 80 to 90 psi generally can be tolerated without untoward effects.[2,3] Scanning electron micrographs of human gingival biopsies confirmed that a 60 psi irrigation force induced no epithelial microulceration or alteration of cell morphology.[4]

Supragingival Irrigation With Water as a Monotherapy

Early investigations reported that supragingival lavage with water did[5,6] and did not[7,8] reduce plaque indices. Decreased plaque deposits were attributed to water lavage or to a direct bactericidal effect, resulting in evacuation of bacterial cell contents.[9]

Several studies indicated that supragingival irrigation with water was unable to resolve gingivitis.[5,10-12] Furthermore, when compared to toothbrushing, irrigation was inferior at attaining or maintaining periodontal health.[5] Therefore, supragingival irrigation with water should not be used in lieu of toothbrushing.

Supragingival Irrigation Using Water or a Placebo Combined With Toothbrushing

When supragingival lavage was employed in conjunction with toothbrushing, there were mixed results regarding its ability to provide additional reduction of gingival inflammation beyond that attained with toothbrushing.[5,6,13-20] However, several studies consistently demonstrated improved periodontal status when irrigation with water or a placebo was used in addition to toothbrushing (Table 1).[13-18,21] It can be concluded that patients who demonstrate proficient toothbrushing and have no gingivitis may not need adjunctive irrigation therapy. However, supragingival lavage can assist individuals with gingivitis or poor oral hygiene.[13-17] The greatest benefit is seen in patients who perform inadequate interproximal cleansing.[5,11,12,19]

* This paper was prepared by the Research, Science and Therapy Committee and approved by the Board of Trustees of the American Academy of Periodontology in May 2005.

Table 1.

Reduction of Clinical Parameters Using Supragingival Irrigation

Reference	N Patients	Agent (%)	Frequency	Study Length	Fluid Amount (mL)	Gingivitis Reduction (%)	Plaque Reduction (%)
Jolkovsky et al.[15]	58	CHX (0.04%)	Daily *	3 months	180	33.1	51.6
		Water	Daily*	3 months	180	18.6	25.6
Newman et al.[13]	155	Water	Daily†	6 months	500	17.8	6.1
		Water and zinc sulfate (0.57%)	Daily†	6 months	300	6.5	9.2
					200		
Flemmig et al.[14]	175	CHX (0.06%)	Daily†	6 months	200	42.5	53.2
		0.12% CHX rinse	bid	6 months	15	24.1	43.3
		Water	Daily†	6 months	200	23.1	0.1
Brownstein et al.[16‡]	44	CHX (0.06%)	Daily†	8 weeks	200	31.1	19.0
		0.12% CHX rinse	Daily	8 weeks	15	19.7	47.9
		Water	Daily†	8 weeks	200	11.0§	Not recorded
Cutler et al.[18]		Water	Daily	14 days	750	50	40
Ciancio et al.[17‡]	66	Phenolic compound‖	bid†	6 weeks	240	54	23
		Hydroalcohol	bid†	6 weeks	240	62	10
Walsh et al.[21]	8	CHX (0.2%)	bid†	8 weeks	500	45	77
		Quinine sulfate	bid†	8 weeks	500	14	2% increase

* Pik Pocket used; note that there was also a subgingival irrigation component.
† Standard irrigation tip employed.
‡ Data accumulated in patients when irrigation was not preceeded by a prophylaxis.
§ 11% reduction of sites scored with a gingival index of 2.
‖ Listerine.
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Among individuals with mild to moderate periodontitis, it was reported in 2005 that routine oral hygiene plus adjunctive irrigation therapy was associated with a significantly greater reduction of proinflammatory cytokines (interleukin 1-β and prostaglandin E_2) in the gingival crevice than oral hygiene without irrigation.[18] This report may explain one possible mechanism by which supragingival irrigation may provide beneficial effects.

Supragingival Irrigation Compared to Rinsing With Medicaments

In a 6-month study, when irrigation with water was compared to rinsing with 0.12% chlorhexidine (CHX), there were no statistical differences in reduction of gingival inflammation.[14] Other short-term investigations of 10 days to 8 weeks noted that rinsing with chlorhexidine was better than irrigating with water.[11,16] Currently, there are insufficient data to unequivocally determine if supragingival lavage with water is superior to rinsing with medicaments or vice versa.

Supragingival Irrigation With Antimicrobial Agents

Supragingival irrigation with medicaments consistently improved clinical[14,17,22] and microbiologic[15,17,23] parameters in individuals with gingivitis. Reported reductions of gingivitis scores ranged from 6.5% to 62% (Table 1).[13-18,21] Some studies indicated that jet irrigation with antimicrobials attained better results than irrigation with water/placebo[3,14,16,21] or

rinsing with antimicrobials.[10,11,14,22] On the other hand, other investigations indicated there were no statistical differences whether a placebo or an antimicrobial was used as an irrigant.[15,17,19] Although, the numerical trend always was better when medicaments were employed, that benefit was small.[15,17,19,22] The data also indicated that irrigation with antimicrobials can aid patients in periodontal supportive therapy by inhibiting development of gingivitis.[15,24,25]

Since jet (oral) irrigators delivered medicaments interproximally more effectively than rinsing,[11] and were able to achieve similar results with reduced drug concentrations,[12] these concentrations were reduced to decrease staining. Subsequently, investigators demonstrated that 0.02%[12] and 0.06%[14] chlorhexidine and 0.02% stannous fluoride solution[3] when delivered in an irrigator were capable of decreasing plaque levels and gingival inflammation. Decreased staining was found, but some still occurred.[3,12,14] It should also be noted that jet irrigation delivered a greater volume of medicaments than rinsing, despite using reduced drug concentrations.[3,11,12,14]

Benefits of supragingival irrigation with antimicrobials were confirmed in the treatment of gingivitis.[13-17] However, when low concentrations of chlorhexidine (0.02%) and metronidazole (0.05%) were used as irrigants in patients with periodontitis, they did not induce clinically significant improvements.[19,20] However, a 0.2% chlorhexidine solution slightly reduced probing depths and decreased plaque and gingival bleeding scores.[21] At present, it is unknown if supragingival irrigation with even higher drug concentrations or other drugs can aid in the treatment of periodontitis.

Subgingival Penetration of Solutions After Supragingival Irrigation

Several investigators employed dyes to study the ability of supragingival irrigation to project solutions subgingivally. These solutions were usually projected 3 mm subgingivally or to half the probing depth (Table 2).[26-29]

The finding that secondary subgingival penetration consistently occurred after supragingival irrigation

Table 2.

Percentage of Dye Penetration Into Periodontal Pockets

Reference	Initial Pocket Depth (mm)	Supragingival Gingival Sulcus Tip	Supragingival Standard Tip*	Subgingival Pik Pocket†	Subgingival Cannula
Eakle et al.[26]	4-8	42.4‡			
Eakle et al.[27]	4-7		46.0‡		
	7		56.0‡		
Larner et al.[28]	4-6		9-42‡		67-80§
	7-10		29-39‡		41-76§‖
Boyd et al.[29]	3.5-6		29.8‡		70.4¶
	6		54.3‡		74.5¶
Braun and Ciancio[32]	6			90‡	
	6			64‡	
Hardy et al.[33]	6.5-10.5				94.5#
Nosal et al.[44]	3-9				100**

* Jet Tip or Water Pik Tip which are the same device.
† Rubber tip placed 1 mm subgingivally, referred to as marginal irrigation.
‡ Dyes were delivered with a jet irrigator.
§ Maxi-I-Probe and Viadent end-release needle placed 3 mm subgingivally.
‖ Lower number (41%) reflects presence of calculus.
¶ Perio Pik placed to half the pocket depth.
# Dye delivered with a syringe; blunt hypodermic needle was inserted 3 mm into the pocket.
** 100% at 86% of the sites evaluated, dye delivered to the base of the pocket with an ultrasonic tip.
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helps to explain why gingival inflammation frequently diminished, despite unchanged plaque levels.[3,5,11,12,14,30] The reduction in gingival inflammation may have been due to diluting plaque toxicity, interference with subgingival plaque maturation, or possibly washing away unattached plaque.[14,30,31]

Studies[26-29,32,33] that addressed subgingival penetration of dyes probably underestimated the percentage of pocket penetration, possibly since the level of connective tissue attachment was used to represent the base of pockets when measurements were calculated on extracted teeth. If the coronal level of the junctional epithelium had been used, the percentage of pocket penetration would have increased. Nevertheless, the data indicate that supragingival irrigation does not routinely project solutions into deep pockets. Therefore, this form of therapy can be beneficial in treating gingivitis, but may not be very effective in the treatment of periodontitis. At present, no studies have evaluated the efficacy of devices that provide marginal irrigation in the treatment of periodontitis.

Induction of Bacteremia

Investigations conducted to assess the potential of supragingival irrigation to induce bacteremia reported mixed results.[34-38] Nevertheless, when the evidence is collectively assessed, it appears that irrigation presents no particular safety hazard to systemically healthy patients, because similar levels of bacteremia were detected after toothbrushing, flossing, periodontal dressing changes, scaling, root planing, and chewing.[39-41] However, clinicians should exercise caution regarding instructions for home irrigation for individuals who require premedication prior to periodontal therapy, because no specific information is available concerning the degree of risk created by home irrigation in this population.

SUBGINGIVAL IRRIGATION

The status of subgingival irrigation in the treatment of periodontitis remains controversial.[42,43] During the past decade numerous studies addressed the impact of subgingival irrigation on clinical and microbiologic parameters. Investigations using subgingival irrigation as a monotherapy and in combination with root planing provided a perspective on the benefits and limitations of this treatment method.

Penetration of Drugs Into Pockets

A device which was placed 1 mm apical to the gingival margin provided what is referred to as marginal irrigation and attained 90% pocket penetration when probing depths were ≤6 mm.[32] Similarly, subgingival irrigation via a cannula placed several millimeters beneath the gingival margin resulted in around 70% to 80% penetration of deep pockets (Table 2).[26-29] It is interesting to note that when an ultrasonic tip was used to deliver a dye, there was minimal lateral dispersion of the stain.[44] Therefore, it may be advantageous to circumferentially irrigate teeth to ensure that drugs are delivered throughout most of the pocket.

Other factors that may affect drug delivery such as calculus, irrigator tip design, and irrigation force have also been studied.[28] Since calculus impeded drug penetration in deep pockets, root planing should precede irrigation therapy. Either a side or end port cannula can be employed, because there appears to be no difference with respect to the depth of solution penetration. Furthermore, low irrigation forces were effective at delivering solutions subgingivally. Therefore, they should be used to minimize the potential of projecting bacteria into tissues.[28]

Pathogen Reduction After Subgingival Irrigation

Subgingival irrigation with medicaments as a monotherapy significantly reduced monitored bacteria (Table 3).[4,45-53] This finding established the potential benefit of this therapy. However, while suspected pathogens were reduced, they were not eliminated. Furthermore, monitored organisms often rebounded to baseline within 1 to 8 weeks after short-term subgingival irrigation (Table 3).[45-48] Tissue invasive organisms also may not respond well to this treatment method. After 6 months of irrigation every 2 weeks with 3% hydrogen peroxide, limited success was achieved in reducing high concentrations of *Actinobacillus actinomycetemcomitans*.[54]

Table 4 lists the studies in which root planing preceded subgingival irrigation. Bacterial reduction was consistently greater and microbes were suppressed longer than when subgingival irrigation was used alone.[52,53,55-58] It can be concluded that root planing greatly enhanced the results and provided the main therapeutic benefit.

Divergent responses regarding bacterial suppression preclude selection of an ideal duration of therapy or irrigation frequency. Even when irrigation was used for 28 consecutive days after initial root planing, investigators still recommended that patients return in 2 to 3 months for periodontal maintenance.[59,60]

Improvement of Clinical Parameters

Subgingival irrigation with medicaments decreased plaque indices, but failed to completely eliminate

Table 3.

Impact of Subgingival Irrigation on Periodontal Pathogens: Monotherapy

Reference	Agent (%)	Bacteria Monitored	Days of Therapy	Reduction (%)	Days to Return to Baseline
Westling et al.[45]	CHX (0.02)	Spirochetes	2*	30 to 10	5
Schmid et al.[46]	SnF_2 (1.64)	Bacteroides	1	Half log	7
Haskel et al.[47]	CHX (0.2)	Spirochetes	14†	41 to 28	28
Lander et al.[48]	CHX (0.2)	Spirochetes, motile forms	1	40 to 20	35-70
Lazzaro and Bissada[49]	SnF_2 (1.64)	Spirochetes	7‡	43-68 to 9	42+ (45% reduction)
Stabholz et al.[50]	CHX (0.12)	Spirochetes	1	31 to 15	84+
	(1.0)	Spirochetes		40 to 9	
	(5.0)	Spirochetes		33 to 5	
Silverstein et al.[51]	(0.5)	Spirochetes	7‡	45 to 25	56§
Listgarten et al.[52]	PDP (7.0)	Spirochetes	56	40 to 29	56§
Wennström et al.[53]	H_2O_2 (3.0)	Spirochetes and motile forms	12‖	19 to 3	Rebounded at 6 months
	CHX (0.2)		12	17 to 9	

* Three times a day.
† 14 consecutive days.
‡ irrigated every other day for 2 weeks.
‖ Three times per week for 2 weeks, weeks 1-2 and 5-6.
§ Had not rebounded to baseline by the end of the study.
TCN: Tetracycline.
PDP: tetrapotassium peroxydiphospate.
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signs of inflammation.[45-53,61] As a monotherapy, it decreased the number of sites that bled upon probing.[47,48,50,53,56,59,61] However, when root planing was also used, there were fewer bleeding points.[53,57,58,62,63] Some studies indicated that subgingival irrigation decreased mean probing depths by only 1 mm,[47,49] but most investigations demonstrated even less reduction.[48,53,59,61,64] If root planing preceded irrigation therapy, probing depths were decreased 2 to 3 mm.[53,56-58] Therefore, if probing depth reduction is desired, root planing is indicated.

Additive Effect

Root planing plus subgingival irrigation. The issue as to whether irrigation with medicaments in conjunction with root planing produces a synergistic effect remains controversial. The first eight studies in Table 5 indicated irrigation did not enhance the therapeutic effect attained by root planing alone.[53,55,57,58,63,65-67] The latter six noted a synergistic effect,[24,56,64,68-70] but the improvement usually was minimal. One study indicated that prolonged (5 minutes per tooth) irrigation with a high concentration of tetracycline (10%) when used in conjunction with root planing enhanced the gain of clinical attachment when compared to root planing alone (1.8 versus 1 mm).[70] However, after 6 months there was no significant difference between treatment methods regarding probing depths or inflammatory status. Other studies which noted synergism were associated with multiple professional irrigation visits[56,68] or frequent self-irrigation by patients.[24,64,68,69] In conclusion, there currently is insufficient evidence to indicate that subgingival irrigation routinely should be used as a supplemental in-office procedure to augment the effects of scaling and root planing. However, preliminary data using high concentrations[56,70] and prolonged or multiple application of antimicrobials[52,53,55-58] have shown some promise in improving periodontal status.

Table 4.

Impact of Subgingival Irrigation on Periodontal Pathogens: Lavage Preceded by Root Planing

Reference	Agent (%)	Bacteria Monitored	Days of Therapy	Reduction (%)	Days to Return to Baseline
Listgarten et al.[52]	PDP (7.0)	Spirochetes	56	75 to 11	56*
Wennström et al.[53]	H_2O_2 (3.0)	Spirochetes and motile forms	6†	18 to 0.5	84*
	CHX (0.2)		6	17 to 0.5	84*
Macauley and Newman[55]	CHX (0.02)	Spiriochetes	28	9 to 4	84*
	Metronidazole (0.05)			16 to 8	
Southard et al.[56]	CHX (2.0)	*P. gingivalis*	4x‡	Majority	105
MacAlpine et al.[57]	CHX (2.0)	Spirochetes	2x/month	32 to 2	168*
	TNC (5.0)		6 months	36 to 1	
Braatz et al.[58]	CHX (2)	Spirochetes	Daily for 168 days	6.8 to 0.8	168

* Had not rebounded to baseline data at the end of the study.
‡ 4 times, once a week.
† 6 times during a 6-week period.
PDP: tetrapotassium peroxydiphosphate; TNC: tetracycline.
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Consequently, additional studies are needed to ascertain the full potential of subgingival irrigation as an adjunct to periodontal therapy.

Ultrasonic debridement with and without antimicrobial agents as the irrigant. Ultrasonic or sonic debridement routinely uses water as a coolant, but it is possible to employ a chemotherapeutic agent as an irrigant. Conceptually, utilization of an antimicrobial agent to enhance bacterial suppression might be beneficial. However, several short-term investigations which compared the efficacy of water versus chlorhexidine delivered through an ultrasonic device reported that there were no significant differences between irrigants regarding the gain of clinical attachment,[71] reduction of probing depths,[71,72] or bleeding upon probing[71,72] (Table 6). In contrast, another study that assessed the effectiveness of chlorhexidine and water noted that chlorhexidine achieved a significantly larger probing depth reduction (difference was <1 mm) at sites with initial probing depths of 4 to 6 mm.[73] However, there was no significant improvement found at sites initially 7 to 9 mm deep.[73] Failure to attain a better clinical result with chlorhexidine was usually attributed to excellent results achieved with ultrasonics and water.

Other clinical trials compared the efficacy of water and povidone iodine (PVP-I) as irrigants administered with an ultrasonic device (Table 6).[71-78] Results from several small studies supported the contention that adjunctive use of PVP-I enhanced non-surgical care, especially at sites with initial probing depths ≥7 mm (Table 6).[75,76] However, due to small study populations, additional data may be necessary before those findings can be characterized as conclusive. Furthermore, the results should be interpreted in light of the fact that several investigations employed a technique referred to as UBD (ultrasonic bacterial debridement).[74-77] UBD usually denotes that a closed flap procedure was performed under local anesthesia.[79] It consists of debridement to the alveolar crest with suturing of interdental papilla and typically requires 1 to 2 hours per quadrant.[79] Thus, improved results should not be interpreted to be due solely to adjunctive PVP-I.

Another long-term clinical trial that compared the efficacy of PVP-I and water via ultrasonic delivery (4 to 6 one-hour debridement sessions) was unable to demonstrate significantly better results with PVP-I regarding reduction of bleeding upon probing.[78] However, there were statistically significantly better results with PVP-I for the final probing depth measurement (2.7 mm versus 2.9 mm), gains of clinical attachment (0.4 mm versus 0.12 mm), and probing depth reduction at sites initially ≥6 mm (1.6 mm versus 1.1 mm).[78]

In conclusion, several studies suggested that adjunctive use of PVP-I might enhance non-surgical

Table 5.

Subgingival Irrigation Plus Root Planing Versus Root Planing Alone

Reference	Agent (%)	Results	Administration	
			Therapist	Patient
Wennström et al.[53]	CHX (0.2), H_2O_2 (3.0)	No synergism	3x/week for 4 weeks	
Macauley and Newman[55]	CHX (0.02), MET (0.05)	No synergism		Daily for 28 days
MacAlpine et al.[57]	CHX (2.0), TCN (5.0)	No synergism	Every 2 weeks for 24 weeks	
Braatz et al.[58]	CHX (2.0)	No synergism		Daily for 24 weeks
Watts and Newman[63]	CHX (0.02)	No synergism		Daily for 28 days
Krust et al.[65]	CHX (0.12), SnF_2 (1.64)	No synergism	4x, once a week	
Herzog and Hodges[66]	chloramine-T (1.0)	No synergism	5x, once a week	
Shiloah and Patters[67]	CHX (0.12) TCN (5.0)	No synergism	1x	Daily for 42 days
Southard et al.[56]	CHX (2.0)	Synergism	4x, once a week	
Rosling et al.[68]	Betadine, NaCL, $NAHCO_3$, H_2O_2	Synergism	Betadine: 1x Slurry: every 2 weeks for 3 months	Slurry bid for 3 months
Khoo and Newman[69]	CHX (0.2), MET (0.5)	Synergism		Daily for 28 days
Wolff et al.[24]	SnF_2 (1.64), iodine	Synergism	1x SnF_2	Daily for 8 weeks/ iodine
Vignarajah et al.[64]	CHX (0.1)	Synergism		Daily for 28 days
Christersson et al.[70]	TCN (10.0)	Synergism	1x for 5 minutes	

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MET: metronidazole; TCN: tetracycline; Slurry: H_2O_2-NaC1 and $NaHCO_3$; iodine: irrigant used by patient.

periodontal therapy. However, small sample sizes and statistically significant results which did not always demonstrate a clinically relevant difference between test and control groups underscore the need for additional large, randomized clinical investigations to determine if ultrasonic debridement plus adjunctive antimicrobial agents provides a clinically relevant improvement of periodontal status beyond ultrasonic debridement with water.

Antimicrobials Versus Placebos as Irrigants

A variety of medicaments have been employed as irrigants to reduce bacterial deposits (Tables 3 through 7). Chlorhexidine is the most studied drug. However, it should be noted that the bactericidal dose of chlorhexidine determined supragingivally (18 to 32 ug/ml) may not be the same subgingivally (modal value 125 ug/ml), because blood and protein can deactivate the drug.[80] For example, it takesa 0.5% chlorhexidine solution 10 minutes to eliminate *Porphyromonas gingivalis* after being mixed with serum.[81]

A lack of substantivity demonstrated by many agents (phenolic rinse, metronidazole, salts) casts doubt on their ability to be effective as subgingival irrigants. It was shown that 50% of a fluorescein-labeled hydroxypropylcellulose gel injected subgingivally was washed out of pockets within 12.5 minutes.[82] Therefore, while bactericidal drug concentrations can be delivered with subgingival irrigation, the medicament may not be retained long enough to have an efficacious effect.

Table 6.

Comparison of Efficacy of Ultrasonic Debridement With and Without Antimicrobial Agents as the Irrigant

Reference	N Patients	Compared Agents (%)	Findings	Study Length
Chapple et al.[71]	14	CHX (0.12%) vs water	NS* for bleeding reduction or CAL†	6 months
Taggart et al.[72]	10	CHX (0.02%) vs water	NS for bleeding or probing depth reduction or CAL	10 weeks
Reynolds et al.[73]	60	CHX (0.12%) vs water	Greater probing depth reduction with CHX (<1 mm) at probing sites initially 4-6 mm, but not different for sites 7-9 mm	28 days
Grossi et al.[74]	113	PVP-I‡ (0.5%) vs water vs 0.12% CH†	NS for CAL, probing depth reduction, or levels of gingival inflammation	6 months
Rosling et al.[75]	20	PVP-I (0.5%) vs water	Comparisons of irrigants alone or with modified Widman flaps Only single rooted teeth evaluated At sites initially ≥7 mm deep, PVP-I gained ~3 mm of CAL vs 2 mm with water (approximated from a graph)	12 months
Christersson et al.[76]	19	PVP-I (0.5%) vs water	Only single rooted teeth evaluated Mean probing depths and mean CAL not reported At probing depths initially ≥7 mm, gains of ≥2 mm CAL at 80% of sites with PVP-I and 55% with water	12 months
Forabosco et al.[77]	8	PVP-I (0.5%) vs Widman flap surgery	NS probing depth reduction or gain of CAL	12 months
Rosling et al.[78]	150	PVP-I (0.1%) vs water	NS bleeding upon probing SS§ gain of CAL (0.4 vs 0.12 mm) SS§ final probing depths, 2.7 vs 2.9 mm	12 months

* Not significant.
† Gain of clinical attachment.
‡ Povidone-iodine.
§ Statistically significant.

Several studies indicated that subgingival irrigation with antimicrobials improved periodontal health better than a placebo[48,50,51,59,64,70,73,75,76,78] whereas others demonstrated that a placebo achieved equivalent results (Table 7).[15,52,53,55,57,63,65,71,72,74,83-86] Similarity of results may be attributed to low drug concentrations that were employed. However, these findings underscore the need for additional research to clarify the ability of subgingival irrigation with medicaments to improve periodontal health.

Potential Uses of Subgingival Irrigation

There are limited data to indicate that a single episode of subgingival irrigation provided by the therapist will enhance the efficacy of root planing.[70] On the other hand, multiple irrigations with antimicrobials may help therapists treat refractory sites with tortuous pockets or furcations where solutions can penetrate into areas inaccessible to instrumentation, but there are limited data to support this assumption.

Table 7.

Different Irrigants Achieved Equivalent Results

Reference	Agent (%)
Listgarten et al.[52]	Tetrapotassium peroxydiphosphate (7.0) vs saline
Wennström et al.[53]	CHX (0.2) vs H_2O_2 (3.0) vs saline
Macauley and Newman[55]	CHX (0.02) vs MET (0.05) vs saline*
Watts and Newman[63]	CHX (0.02) vs saline*
Krust et al.[65]	CHX (0.12) vs SnF_2 (1.64) vs saline
MacAlpine et al.[57]	CHX (2.0) vs TCN (5.0) vs saline
Kaugers et al.[83]	Viadent versus Viadent (0.3 sanguinarine)†
Taggart et al.[72]	CHX (0.02) versus water*
Nyland and Egelberg[84]	Saline vs TCN (5.0)
Schlagenhauf et al.[85]	Saline vs CHX (0.1)
Jolkovsky et al.[15]	CHX (0.04) vs water‡
Linden and Newman[86]	Saline vs MET (0.5)
Chapple et al.[71]	CHX (0.12) vs water
Grossi et al.[74]	CHX (0.12) vs water vs PVP-I (0.5)

* CHX concentration was weak (0.02%).
† Irrigation done with and without active agent (sanguinarine).
‡ Irrigation with Pik Pocket.
MET: Metronidazole.
TCN: Tetracycline.
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There also are no in vivo data to suggest that sequential irrigation with different medicaments provides any benefit beyond any one type of drug. Furthermore, there are no clinical trials to indicate that irrigation can be used to detoxify failing implants.

Conceptually, the greatest advantage of self-administered subgingival irrigation is that it permits patients to participate in maintaining the bacterial reduction that was attained during root planing. Previously, patient participation was limited to supragingival brushing and interdental cleaning. Subgingival irrigation allows individuals to actively engage in self-therapy at problem sites and potentially have a direct effect on the microflora.

Professional Versus Personal Application of Subgingival Irrigation

There are no long-term studies that compared the benefit of personal versus professional administration of subgingival irrigation. Three different methods of professionally administered subgingival irrigation have been studied: 1) syringe;[58,62,87] 2) jet irrigator with a cannula;[55,63,64,87] and 3) an ultrasonic unit.[44,71-78] Results employing a syringe or a jet irrigator with a cannula were equally effective.[87] There are no data comparing these techniques to drug delivery via an ultrasonic device.

It is recognized that many individuals may not have the dexterity to irrigate with a subgingival cannula and that compliance can present another pitfall. However, marginal irrigation that results in significant subgingival penetration[32] has been successfully used by maintenance patients, and is a technique that is easy to master.[15,24,25]

SAFETY OF SUPRA- AND SUBGINGIVAL IRRIGATION THERAPY

In general, supra- and subgingival irrigation have not produced any deleterious effects. However, it may be prudent to avoid these modes of therapy in patients with gingivitis or periodontitis if they have a medical history which dictates that premedication is required prior to conventional therapy. It should also be noted that a disadvantage of delivering antimicrobials via power-driven scalers is the creation of contaminated aerosols.[88-90] In this regard, high-speed evacuation devices could be an aid in controlling splatter of infectious material (e.g., bacteria, blood).[91,92] Furthermore, utilization of an antimicrobial mouthrinse before sonic or ultrasonic debridement may help reduce infectious agents in aerosols.[93-96]

CONCLUSIONS

Supragingival and marginal irrigation will continue to play a role in the treatment of gingivitis and maintenance of periodontal patients. However, there is a paucity of data to support the contention that a single episode of subgingival irrigation increases the immediate impact or duration of root planing efficacy. Similarly, there is limited information to suggest that multiple in-office irrigation appointments provide a substantial benefit beyond root planing. These conclusions are based upon the preponderance of published studies. However, it should be noted that there is some preliminary data which suggests that irrigation with high concentrations of substantive drugs may enhance the efficacy of root

planing. In this regard, additional research is needed to verify the utility of this treatment modification.

Conceptually, irrigation therapy may be of increased value when root planing is less than ideal due to anatomy or other factors. However, it appears that the greatest shortcoming of irrigation therapy is the quick elimination of subgingivally placed drugs. To ameliorate this problem, when appropriate, conventional therapy can be augmented with subgingivally placed adjunctive aids (e.g., bioabsorbable polymers) that provide slow release of medicaments.[97] These devices will ensure that a bactericidal dose is maintained for an adequate duration of time to reduce pathogens. The future of chemotherapeutic management of the subgingival flora is promising and should provide a more predictable adjunct to treat and maintain periodontal patients.

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REFERENCES

1. Bhaskar SN, Cutright DE, Gross A. Water jet devices in dental practice. *J Periodontol* 1971;42:658-664.
2. Bhaskar SN, Cutright DE, Frisch J. Effect of high pressure water jet on oral mucosa of varied density. *J Periodontol* 1969;40:593-598.
3. Boyd RL, Leggott P, Quinn R, Buchanan S, Eakle W, Chambers D. Effect of self-administered daily irrigation with 0.02% SnF_2 on periodontal disease activity. *J Clin Periodontol* 1985;12:420-431.
4. Cobb CM, Rodgers RL, Killoy WJ. Ultrastructural examination of human periodontal pockets following the use of an oral irrigation device in vivo. *J Periodontol* 1988;59:155-163.
5. Hugoson A. Effect of the Water Pik device on plaque accumulation and development of gingivitis. *J Clin Periodontol* 1978;5:95-104.
6. Hoover DR, Robinson HB. The comparative effectiveness of a pulsating oral irrigator as an adjunct in maintaining oral health. *J Periodontol* 1971;42:37-39.
7. Emslie RD. The value of oral hygiene. *Br Dent J* 1964;117:*373-383*; discussion 383-387.
8. Covin NR, Lainson PA. The effects of stimulating the gingiva by a pulsating water device. *J Periodontol* 1973;44:286-293.
9. Brady JM, Gray WA, Bhaskar SN. Electron microscopic study of the effect of water jet lavage devices on the dental plaque and gingivitis. *J Periodontol* 1973;52:1310-1313.
10. Southard GL, Parson LG, Thomas JR. Effect of sanguinaria on development of plaque and gingivitis when supragingivally delivered as a manual rinse or under pressure in an oral irrigator. *J Clin Periodontol* 1981;8:177-188.
11. Lang NP, Räber K. Use of oral irrigators as vehicle for the application of antimicrobial agents in chemical plaque control when applied by an oral irrigator. *J Clin Periodontol* 1981;8:177-188.
12. Lang NP, Ramseier-Grossman K. Optimal dosage of chlorhexidine digluconate in chemical plaque control when applied by an oral irrigator. *J Clin Periodontol* 1981;8:189-202.
13. Newman MG, Cattabriga M, Etienne D, et al. Effectiveness of adjunctive irrigation in early periodontitis. Multi-center evaluation. *J Periodontol* 1994;65:224-229.
14. Flemmig TF, Newman MG, Doherty F, et al. Supragingival irrigation with 0.06% chlorhexidine in naturally occurring gingivitis. I. 6-month clinical observations. *J Periodontol* 1990;61:112-117.
15. Jolkovsky DL, Waki MY, Newman MG, et al. Clinical and microbiological effects of subgingival and gingival marginal irrigation with chlorhexidine gluconate. *J Periodontol* 1990;61:663-669.
16. Brownstein CN, Briggs S, Schweitzer KL, et al. Irrigation with chlorhexidine to resolve naturally occurring gingivitis: A methodologic study. *J Clin Periodontol* 1990;17:588-593.
17. Ciancio SG, Mather ML, Zambon JJ, Reynolds H. Effect of a chemotherapeutic agent delivered by an oral irrigation device on plaque, gingivitis, and subgingival microflora. *J Periodontol* 1989;60:310-315.
18. Cutler CW, Stanford TW, Abraham C, et al. Clinical benefits of oral irrigation for periodontitis are related to reduction of pro-inflammatory cytokine levels and plaque. *J Clin Periodontol* 2000;27:134-143.
19. Aziz-Gandour IA, Newman HN. The effects of a simplified oral hygiene regime plus supragingival irrigation with chlorhexidine or metronidazole on chronic inflammatory periodontal disease. *J Clin Periodontol* 1986;13:228-236.
20. Sanders PC, Linden GJ, Newman H. The effects of a simplified mechanical oral hygiene regime plus supragingival irrigation with chlorhexidine or metronidazole on subgingival plaque. *J Clin Periodontol* 1986;13:237-242.
21. Walsh TF, Glenwright HD, Hull PS. Clinical effects of pulsed oral irrigation with 0.2% chlorhexidine digluconate in patients with adult periodontitis. *J Clin Periodontol* 1992;19:245-248.
22. Parsons LG, Thomas LG, Southard GL, et al. Effect of sanguinaria extract on established plaque and gingivitis when supragingivally delivered as a manual rinse under pressure in an oral irrigator. *J Clin Periodontol* 1987;14:381-385.
23. Newman MG, Flemmig TF, Nachnani S, et al. Irrigation with 0.06% chlorhexidine in naturally occurring gingivitis. II. 6-month microbiological observations. *J Periodontol* 1990;61:427-433.
24. Wolff L, Bakdash MB, Pihlstrom BL, Bandt C, Aeppli DM. The effect of professional and home subgingival

irrigation with antimicrobial agents on gingivitis and early periodontitis. *J Dent Hyg* 1989;63:222-225, 241.
25. Waki MY, Jolkvosky DL, Otomo-Corgel J, et al. Effects of subgingival irrigation on bacteremia following scaling and root planing. *J Periodontol* 1990;61: 405-411.
26. Eakle W, Boyd RL, Robertson PB, et al. Penetration of periodontal pockets with irrigation by a newly designed tip. *J Dent Res* 1988;67:400 (Abstr. 2295).
27. Eakle W, Ford C, Boyd RL. Depth of penetration in periodontal pockets with oral irrigation. *J Clin Periodontol* 1986;13:39-44.
28. Larner JR, Greenstein G. Effect of calculus and irrigation tip design depth of subgingival irrigation. *Int J Periodontics Restorative Dent* 1993;13: 288-297.
29. Boyd RL, Hollander BN, Eakle WS. Comparison of subgingivally placed cannula oral irrigator tip with a supragingival placed standard irrigator tip. *J Clin Periodontol* 1992;19:340-344.
30. Derdivanis JP, Bushmaker S, Dagenais F. Effects of a mouthwash in an irrigating device on accumulation and maturation of dental plaque. *J Periodontol* 1978; 49:81-84.
31. Fine DH, Letizia OJ, Mandel ID. The effect of rinsing with Listerine antiseptic on the properties of developing dental plaque. *J Clin Periodontol* 1985;12:660-666.
32. Braun RE, Ciancio SG. Subgingival delivery by an oral irrigation device. *J Periodontol* 1992;63:469-472.
33. Hardy JH, Newman HN, Strahan JD. Direct irrigation and subgingival plaque. *J Clin Periodontol* 1982;9: 57-65.
34. Romans AR, App GR. Bacteremia, a result from oral irrigation in subjects with gingivitis. *J Periodontol* 1971;42:757-760.
35. Witzenberger T, O'Leary TJ, Gillette WB. Effect of a local germicide on the occurrence of bacteremia during subgingival scaling. *J Periodontol* 1982;53: 172-179.
36. Felix JE, Rosen S, App GR. Detection of bacteremia after the use of an oral irrigation device in subjects with periodontitis. *J Periodontol* 1971;42:785-787.
37. Sconyers JR, Crawford JJ, Moriarty JD. Relationship of bacteremia to tooth brushing in patients with periodontitis. *J Am Dent Assoc* 1973;87:616-622.
38. Silver JG, Martin AW, McBride BC. Experimental transient bacteremias in human subjects with clinically healthy gingiva. *J Clin Periodontol* 1979;6:33-36.
39. Carroll GC, Sebor RJ. Dental flossing and its relationship to transient bacteremia. *J Periodontol* 1980;51: 691-692.
40. Wampole HS, Allen AL, Gross A. The incidence of transient bacteremia during periodontal dressing change. *J Periodontol* 1978;49:462-464.
41. Lofthus JE, Waki M, Jolkovsky D, et al. Bacteremia following subgingival irrigation and scaling and root planing. *J Periodontol* 1991;62:602-607.
42. Hallmon WW, Rees TD. Local anti-infective therapy: Mechanical and physical approaches. A systematic review. *Ann Periodontol* 2003;8:99-114.
43. Shiloah J, Hovious LA. The role of subgingival irrigations in the treatment of periodontitis. *J Periodontol* 1993;64:835-843.
44. Nosal G, Scheidt MJ, O'Neal R, Van Dyke TE. The penetration of lavage solution into the periodontal pocket during ultrasonic instrumentation. *J Periodontol* 1991;62:554-557.
45. Westling M, Tynelius-Bratthall G. Microbiological and clinical short-term effects of repeated intracrevicular chlorhexidine rinsing. *J Periodontal Res* 1984;19:202-209.
46. Schmid E, Kornman KS, Tinanoff N. Changes of subgingival total colony forming units and black pigmented bacteroides after a single irrigation of periodontal pockets with 1.64% SnF_2. *J Periodontol* 1985;56:330-333.
47. Haskel E, Esquenasi J, Yussim L. Effects of subgingival chlorhexidine irrigation in chronic moderate periodontitis. *J Periodontol* 1986;57:305-310.
48. Lander PE, Newcomb GM, Seymour G, Powell N. The antimicrobial and clinical effects of a single subgingival irrigation of chlorhexidine in advanced periodontal lesions. *J Clin Periodontol* 1986;13:74-80.
49. Lazzaro AJ, Bissada NF. Clinical and microbiologic changes following the irrigation of periodontal pockets with metronidazole or stannous fluoride. *Periodontol Case Rep* 1989;1:12-19.
50. Stabholz A, Nicholas AA, Zimmerman GJ, Wikesjö UME. Clinical and antimicrobial effects of a single episode of subgingival irrigation with tetracycline HCL or chlorhexidine in deep periodontal pockets. *J Clin Periodontol* 1998;25:794-800.
51. Silverstein L, Bissada N, Manouchehr-Pour M, Greenwell H. Clinical and microbiologic effects of local tetracycline irrigation on periodontitis. *J Periodontol* 1988;59:301-305.
52. Listgarten M, Grossberg D, Schwimer AV, Gaffer A. Effect of subgingival irrigation with tetrapotassium peroxydiphosphate on scaled and untreated periodontal pockets. *J Periodontol* 1989;60:4-11.
53. Wennström JL, Dahlén G, Gröndahl K, Heijl L. Periodic subgingival antimicrobial irrigation of pockets. II. Microbiologic and radiographical observations. *J Clin Periodontol* 1987;14:573-580.
54. Wikesjö UMF, Reynolds HS, Christersson LA, Zambon JJ, Genco RJ. Effects of subgingival irrigation on *A. actinomycetemcomitans*. *J Clin Periodontol* 1989;16: 116-119.
55. Macaulay WJ, Newman HN. The effect on the composition of subgingival plaque of a simplified oral hygiene system including pulsating jet subgingival irrigation. *J Periodontal Res* 1986;21:375-385.
56. Southard S, Drisko CL, Killoy WJ, et al. The effects of 2% chlorhexidine digluconate irrigation on the clinical parameters and level of *Bacteroides gingivalis* in periodontal pockets. *J Periodontol* 1989;60:302-309.
57. MacAlpine R, Magnusson I, Kiger R, Crigger M, Garrett S, Egelberg J. Antimicrobial irrigation of deep pockets to supplement oral hygiene instruction and root debridement. I. Bi-weekly irrigation. *J Clin Periodontol* 1985;12:568-577.

58. Braatz L, Garrett S, Claffey N, Egelberg J. Antimicrobial irrigation of deep pockets to supplement nonsurgical periodontal therapy. II. Daily irrigation. *J Clin Periodontol* 1985;12:630-638.
59. Soh LL, Newman HN, Strahan JD. Effects of subgingival chlorhexidine irrigation on periodontal inflammation. *J Clin Periodontol* 1982;9:66-74.
60. Wieder SG, Newman HN, Strahan JD. Stannous fluoride and subgingival chlorhexidine irrigation in the control of plaque and chronic periodontitis. *J Clin Periodontol* 1983;10:172-181.
61. Fine JB, Harper DS, Gordon JM, Hovliaras CA, Charles CH. Short-term microbiological and clinical effects of subgingival irrigation with an antimicrobial mouthrinse. *J Periodontol* 1994;65:30-36.
62. Wan Yusof W, Newman HN, Strahan JD, et al. Subgingival metronidazole in dialysis tubing and subgingival chlorhexidine irrigation in the control of chronic inflammatory periodontal disease. *J Clin Periodontol* 1984;11:166-175.
63. Watts EA, Newman HN. Clinical effects on chronic periodontitis of a simplified system of oral hygiene including subgingival pulsated jet irrigation with chlorhexidine. *J Clin Periodontol* 1986;13:666-670.
64. Vignarajah S, Newman HN, Bulman J. Pulsated jet subgingival irrigation with 0.1% chlorhexidine, simplified oral hygiene and chronic periodontitis. *J Clin Periodontol* 1989;16:365-370.
65. Krust KS, Drisko CL, Gross K, Overman P, Tira DE. The effects of subgingival irrigation with chlorhexidine and stannous fluoride: A preliminary investigation. *J Dent Hyg* 1991;65:289-295.
66. Herzog A, Hodges KO. Subgingival irrigation with chloramine-T. *J Dent Hyg* 1988;62:515-552.
67. Shiloah J, Patters MR. DNA probe analyses of the survival of selected periodontal pathogens following scaling, root planing, and intra-pocket irrigation. *J Periodontol* 1994;65:568-575.
68. Rosling BG, Slots J, Webber RL, Christersson LA, Genco RJ. Microbiological and clinical effects of topical subgingival and antimicrobial treatment on human periodontal disease. *J Clin Periodontol* 1983; 10:487-514.
69. Khoo JGL, Newman HN. Subgingival plaque control by a simplified oral hygiene regime plus local chlorhexidine or metronidazole. *J Periodontal Res* 1983; 18:607-619.
70. Christersson LA, Norderyd OM, Puchalsky CS. Typical application of tetracycline-HCL in human periodontitis. *J Clin Periodontol* 1993;20:88-95.
71. Chapple IL, Walmsley AD, Saxby MS, Moscrop H. Effect of subgingival irrigation with chlorhexidine during ultrasonic scaling. *J Periodontol* 1992;63:812-816.
72. Taggart JA, Palmer RM, Wilson RF. A clinical and microbiological comparison of the effects of water and 0.02% chlorhexidine as coolants during ultrasonic scaling and root planing. *J Clin Periodontol* 1990;17:32-37.
73. Reynolds MA, Lavigne CK, Minah GE, Suzuki JB. Clinical effects of simultaneous ultrasonic scaling and subgingival irrigation with chlorhexidine. Mediating influence of periodontal probing depths. *J Clin Periodontol* 1992;19:595-600.
74. Grossi G, Skrepcinski FB, DeCaro T, et al. Treatment of periodontal disease in diabetics reduces glycated hemoglobin. *J Periodontol* 1997;68:713-719.
75. Rosling BG, Slots J, Christersson LA, Grondahl HG, Genco RJ. Topical antimicrobial therapy and diagnosis of subgingival bacteria in the management of inflammatory periodontal disease. *J Clin Periodontol* 1986;13:975-981.
76. Christersson LA, Rosling BG, Dunford R, et al. Monitoring of subgingival *Bacteroides gingivalis* and *Actinobacilllus actinomycetemcomitans* in the management of advanced periodontitis. *Adv Dent Res* 1988;2:382-388.
77. Forabosco A, Baletti R, Spinato S, Colao P, Casolari C. A comparative study of a surgical method and scaling and root planing using the Odontoson. *J Clin Periodontol* 1996;23:611-614.
78. Rosling B, Hellstrom MK, Ramberg P, et al. The use of PVP-iodine as an adjunct to non-surgical treatment of chronic periodontitis. *J Clin Periodontol* 2001; 28:1023-1031.
79. Genco RJ, Christersson LA. Anti-infective therapy for gingivitis and periodontitis. In: Genco RJ, Goldman HM, Cohen DW, eds. *Contemporary Periodontics*. St. Louis: CV Mosby; 1990:427-441.
80. Stanley A, Wilson M, Newman HN. The in vitro effects of chlorhexidine on subgingival plaque bacteria. *J Clin Periodontol* 1989;16:259-264.
81. Oosterwaal PJM, Mikx FHM, Van den Brink ME, et al. Bactericidal concentrations of chlorhexidine digluconate, amine fluoride gel and stannous fluoride gel for subgingival bacteria tested in serum at short contact times. *J Periodontal Res* 1989;24:155-160.
82. Oosterwaal PJM, Mikx FHM, Renggli HH. Clearance of a topically applied fluorescein gel from periodontal pockets. *J Clin Periodontol* 1990;17:613-615.
83. Kaugers C, Schenkein HA, Palcanis KG, Best AM. Effects of subgingival irrigation with viadent on human subgingival plaque in chronic periodontitis. *J Dent Res* 1988;67:184 (Abstr. 575).
84. Nylund K, Egelberg J. Antimicrobial irrigation of periodontal furcation lesions to supplement oral hygiene instruction and root debridement. *J Clin Periodontol* 1990;17:90-95.
85. Schlagenhauf U, Stellwas P, Fiedler A. Subgingival irrigation in the maintenance phase of periodontal therapy. *J Clin Periodontol* 1990;17:650-653.
86. Linden GJ, Newman HN. The effects of subgingival irrigation with low dosage metronidazole on periodontal inflammation. *J Clin Periodontol* 1991;18: 177-181.
87. Itic J, Serfaty R. Clinical effectiveness of subgingival irrigation with a pulsated jet irrigator versus syringe. *J Periodontol* 1992;63:174-181 (erratum 1992;63: 565).
88. Miller RL. Characteristics of blood-containing aerosols generated by commonly found dental instruments. *Am Ind Hyg Assoc J* 1995;56:670-676.
89. Holbrook WP, Muir KF, MacPhee IT, et al. Bacteriological investigation of the aerosol from ultrasonic scalers. *Br Dent J* 1978;144:245-247.

90. Legnani P, Checchi L, Pelliccioni GA, et al. Atmospheric contamination during dental procedures. *Quintessence Int* 1994;25:435-439.
91. Harrel SK, Barnes JB, Rivera-Hidalgo F. Reduction of aerosols produced by ultrasonic scalers. *J Periodontol* 1996;67:28-32.
92. Harrel SK. Clinical use of an aerosol-reduction device with an ultrasonic scaler. *Compend Cont Educ Dent* 1996;17:1185-1194.
93. Fine DH, Furgang D, Korik I, et al. Reduction of viable bacteria in dental aerosols by preprocedural rinsing with an antiseptic mouthrinse. *Am J Dent* 1993;6:219-221.
94. Fine DH, Mendieta C, Barnett ML, et al. Efficacy of preprocedural rinsing with an antiseptic in reducing viable bacteria in dental aerosols. *J Periodontol* 1992; 63:821-824.
95. Fine DH, Yip J, Furgang D, et al. Reducing bacteria in dental aerosols: Preprocedural use of an antiseptic mouthrinse. *J Am Dent Assoc* 1993;124:56-58.
96. Veksler AE, Kayrouz GA, Newman MG. Reduction of salivary bacteria by preprocedural rinses with chlorhexidine 0.12%. *J Periodontol* 1991;62:649-651.
97. American Academy of Periodontology. The role of controlled drug delivery for periodontitis (position paper). *J Periodontol* 2000;71:125-140.
98. Greenstein G. Supragingival and subgingival irrigation: Practical application in the treatment of periodontal diseases. *Compend Contin Educ Dent* 1992; 13:1098, 1102, 1104 passim.
99. Greenstein G. Subgingival irrigation: An adjunct to periodontal therapy. *J Dent Hyg* 1990;64:389-397.