ORIGINAL ARTICLE

NONSURGICAL TREATMENT OF PERIODONTITIS

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ABSTRACT

Context. Scaling and root planing (SRP) is the gold standard treatment for most patients with chronic periodontitis. Nevertheless, in the last years, different therapeutic strategies have been proposed to improve the results of SRP and hence to avoid the need of periodontal surgical interventions in some patients with advanced periodontitis. They are based on modifications of standard therapies (such as enhancement of instrument tip designs), on development of new technologies (such as lasers), or development of alternative treatment protocols (eg, full-mouth disinfection). The purpose of this review is, therefore, to update the scientific evidence based on randomized clinical trials (RCT) evaluating these advanced nonsurgical therapies that have been published between January 2010 and March 2012.

Evidence Acquisition. RCTs published between January 2010 and March 2012 have been selected. Previous systematic reviews were used as a start point. Three distinct aspects were evaluated independently: the modification of conventional instruments, the advent of new technologies, and the development of new treatment protocols.

Evidence Synthesis. Twenty-two publications were selected: 4 were related to modifications of standard therapies (new tip designs and local anesthetics), 14 to new technologies (new ultrasonic devices, air abrasive systems, endoscope and lasers), and 4 to new treatment protocols.

Conclusions. These technological advances and the development of new protocols may improve patient-related outcomes and cost-effectiveness, although they have not shown significant differences in efficacy when compared with conventional SRP.

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INTRODUCTION

The primary goal of periodontal therapy is to preserve the natural dentition, by arresting the chronic inflammatory process, that results in loss of periodontal attachment and alveolar bone and formation of periodontal pockets. The current understanding on the etiology and pathogenesis of periodontitis acknowledges that this disease is the result of a complex interplay of bacterial aggression and host response, modified by behavioral and systemic risk factors. The pathogens are organized in communities (biofilms) adhered to the root surface in the subgingival environment, which are usually resistant to both the natural antibacterial defense mechanisms present in the oral cavity and to any chemical antibacterial medication.[1] Only therapies achieving the mechanical disruption of subgingival biofilms

Keywords: Periodontitis, nonsurgical therapy, laser, power-driven, curettes.

TABLE 1. Study design of publications on conventional SRP

1st author	Year	Country	n (final)	Design	Duration	Test	Control
Casarin	2010	Brazil	15 (15)	Split-mouth	2 mo	PP & OHI; US scaler thin tip	PP & OHI; US scaler conventional tip
Muhney	2010	EE.UU.	75 (75)	Split-mouth	0 d	Piezoelectric US device	Magnetostrictive US device
Chung	2011	Korea	40 (40)	Split-mouth	1 d	SRP (US) with or without EMLA	SRP (curettes) with or without EMLA
Pandit	2010	India	25 (25)	Split-mouth	0 d	Test 1: SRP (curettes) + EMLA Test 2: SRP(curettes) + lignocaine patch Test 3: SRP (curettes)+ EDA	

EDA, electronic dental anesthesia; EMLA, Eutectic mixture of local anesthesia; OHI, oral hygiene instructions; PP, professional prophylaxis; SRP, scaling and root planing; US, ultrasonic device.

have proven successful and, hence, periodontal health can be maintained only provided there is adequate plaque control by the patient and frequent professional prophylaxis.[2]

Mechanical root debridement is the cornerstone of cause-related periodontal therapy and it is aimed at removal of subgingival biofilm and calculus, which together with the patient's oral hygiene practices will prevent bacterial recolonization and formation of supragingival biofilms. This debridement is usually carried out with hand instruments (curettes and scalers) and staged in different sessions (by quadrants or sextants). This conventional protocol is termed scaling and root planning (SRP) and it has proven to be the gold standard of periodontal therapy for most patients with chronic periodontitis. Its efficacy is well documented in systematic[3-5] and narrative reviews[6-8] by the demonstration of gains in clinical attachment levels (CAL), reductions in probing pocket depths (PPD), and in the frequency of bleeding on probing (BOP). SRP is able to significantly improve CAL levels between 0.55 and 1.29 mm and to reduce PPD between 1.29 and 2.16 mm, these results being mostly dependent on the extent and severity of disease.[2] These results are, however, not dependent on the mode of debridement, as power-driven instrumentation has demonstrated similar outcomes when compared with hand instrumentation.[9,10] The results are dependent rather on the presence of local factors, such as deep and tortuous pockets, furcations, and angular bony lesions, which may limit the reach of nonsurgical debridement,[11] as well as on patient's related factors, such as tobacco smoking and the compliance with plaque control.[12]

In the past years different therapeutic strategies have been proposed to improve the results of SRP and hence to avoid the need of periodontal surgical interventions. These additional therapies are based on modifications of standard therapies (such as enhancement of instrument tip designs), on development of new technologies (such as lasers), or development of alternative treatment protocols (eg, full-mouth disinfection). The purpose of this review is, therefore, to update the scientific evidence based on randomized clinical trials (RCTs) evaluating these advanced nonsurgical therapies that have been published between January 2010 and March 2012.

MODIFICATION OF STANDARD THERAPIES

Traditionally, SRP has been performed with curettes, which have been modified by changing the shape of the instrument or the active tip (eg, After Five and Mini-Five curettes) to optimize their instrumentation efficacy in areas of difficult access.[13] Similarly, power-driven instrument devices using sonic or ultrasonic technologies have improved their outcome performance and modified their application tips so as to improve their capacity of subgingival plaque and calculus removal. Moreover, these devices have incorporated irrigation systems to increase their efficacy by the adjunctive activity of antimicrobials (chlorhexidine, saline, or hydrogen peroxide). In addition, modifications of traditional approaches have also aimed to improve patient-based variables.

The search of RCTs evaluating these modifications rendered 4 studies that have used split-mouth designs. Their results are summarized in **Tables 1 and 2**. One study evaluated the short and intermediate outcomes of performing SRP with different ultrasonic tip inserts.[14] The use of new thin ultrasonic tips was not associated with improved clinical outcomes 3 months after treatment and resulted in short term CAL loss. In another study, the evaluation of modern power-driven devices resulted in less pain and vibration sensation after scaling with a piezoelectric when compared with a conventional magnetostrictive ultrasonic device.[15] The other 2 RCTs tested different anesthetic techniques during SRP procedures: Chung et al[16] compared scaling with an ultrasonic device or curettes, with and without the use of a nonpunctured lidocaine

TABLE 2. Main findings of publications on conventional SRP

1st author	Year	Clinical variables	Main conclusion
Casarin	2010	RAL, RGP, PD, ICAL	Higher immediate clinical attachment loss inflicted by thin ultrasonic tips during instrumentation, but it did not affect the clinical response to the nonsurgical treatment.
Muhney	2010	Level of discomfort (pain), vibration and noise (VAS)	The patients prefer instrumentation with the piezoelectric as it relates to awareness of associated discomfort and vibration.
Chung	2011	Pain levels (VAS & VRS)	A significant reduction of pain is achieved by using EMLA cream and US.
Pandit	2010	Pain levels (VAS & VRS)	EMLA and lignocaine patch are more effective than EDA and comparable.

ICAL, immediate clinical attachment loss; PD, probing depth; RAL, relative attachment level; RGP, relative gingival position; SRP, scaling and root planing; VAS, visual analog scale; VRS, verbal rating scale; US, ultrasonic device.

anesthetic (eutectic mixture of local anesthetics [EMLA]), and patients significantly experienced less pain when using EMLA and the ultrasonic device. Pandit et al[17] compared 3 different types of topical anesthesia when performing SRP with curettes, and EMLA also resulted in the least perception of pain by the patients.

In summary, most of the tested modifications have not rendered significant benefits in clinical outcomes, although modern piezoelectric ultrasonic devices and the use of EMLA seem to improve patient-related outcomes, since patients experienced less pain and discomfort when compared with standard modes of instrumentation. These results, however, are derived from few studies with small samples. There is a need for RCTs with adequate samples and designs, and adhesion to the Consolidated Standards of Reporting Trials (CONSORT) guidelines, in order to truly assess the benefits of these enhancements in periodontal instrumentation devices and techniques.

NEW TECHNOLOGIES

New technologies are being developed with the aim of outperforming the classical hand- and power-driven root instrumentation systems in the nonsurgical treatment of chronic periodontitis.

Modified Ultrasonic Systems

Two modified ultrasonic instrumentation systems (Vector and PerioScan) have been released to effectively remove subgingival plaque and calculus and at the same time avoid some of the side effects of standard power-driven devices, such as dentinal hypersensitivity, thermal changes leading to pulp symptomatology, changes in the marginal gingival tissue, transmission of infections via aerosol, acoustic lesions, and possible effects on cardiac pacemakers.

The Vector system (Dürr Dental, Bietigheim-Bissingen, Germany) is a modification of a conventional ultrasonic device, where the horizontal vibration is converted by a resonating ring into a vertical vibration, resulting in a parallel movement of the working tip to the tooth surface. The intended purpose is to provide a less painful treatment with greater PPD reductions and CAL gains when compared with conventional SRP. The clinical evidence, however, does not substantiate these claims and, on the contrary, Slot et al[18] demonstrated that the Vector system obtained comparable clinical and microbiological results when compared with SRP either with hand instruments or with power-driven devices in moderately deep pockets. However, more time was needed for achieving similar outcomes with the Vector system. Similar results were reported by Guentsch and Preshaw,[19] showing that the Vector system was less efficient when removing large masses of calculus.

PerioScan (Sirona, Bensheim, Germany) is an ultrasonic device that provides a detection mode to discriminate between calculus deposits and smooth clean roots, using both a visual and an acoustical signal. It has shown to have a positive predictive value of 0.59 for detecting calculus and a negative predictive value of 0.97 in the presence of clean root surfaces.[20] There are, however, no controlled studies evaluating the efficacy of this device with conventional SRP.

Air Abrasive Systems

Standard powdered air abrasive systems are based on the air-spray of sodium bicarbonate. They are used for polishing and removing tooth stains, but cannot be used for root instrumentation because they cause hard and soft tissue damage owing to their high abrasiveness.[21] Recently, a powered air abrasive system based on a low-abrasive amino acid glycine powder has demonstrated to effectively remove biofilm from the root surface without damaging the hard and soft tissues.[22] Two recent comparative studies have evaluated the efficacy of this air abrasive glycine system when compared with standard SRP. The first study evaluated the short-term efficacy (7 days) of glycine powder air spray in residual pockets of patients in supportive periodontal therapy (SPT), when compared with SRP with curettes. No significant differences were detected in either clinical or microbiological outcome variables, although patients preferred the glycine treatment

TABLE 3. Study design of publications on lasers

1st author	Year	Country	n (final)	Design	Duration	Test	Control
Aykol	2011	Turkey	36 (36)	Parallel	6 mo	SRP + LLLT 808 nm (1, 2, and 7 d)	SRP
Braun	2010	Germany	40 (40)	SM	3 mo	Er:YAG	Sonic scaler
Cappuyns	2011	Switzerland	32 (29)	SM	6 mo	Test 1: PDT Test 2: Diode (810 nm)	SRP
De Micheli	2010	Brazil	28 (27)	SM	6 wk	SRP + Diode 810 nm (1 & 7 d)	SRP
Eltas	2011	Turkey	20 (20)	SM	9 mo	SRP + Nd:YAG	SRP
Gómez	2010	Spain	30 (NR)	Parallel	8 wk	SRP + Nd:YAG	SRP
Kelbauskiene	2011	Lithuania	30 (NR)	SM	12 mo	SRP + Er,Cr:YSGG	SRP
Jin	2010	China	18 (18)	SM	4 wk	SRP + Diode (810 nm)	SRP + Curettage
Lopes	2010	Brazil	21 (19)	SM	12 mo	Test 1: SRP+ Er:YAG Test 2: Er:YAG	Control 1: SRP Control 2: None
Qadri	2010	Sweden	22 (22)	SM	20 mo (median)	SRP + Nd:YAG	SRP
Qadri	2010b	Sweden	30 (30)	SM	3 mo	SRP + Nd:YAG	SRP
Romeo	2010	Italy	15 (NR)	SM	6 wk	Test 1: KTP + SRP + CHX Test 2: KTP + SRP	C1: SRP+CHX C2: SRP+POV
Rotundo	2010	Italy	27 (26)	SM	6 mo	Test 1: SRP + Er:YAG Test 2: Er:YAG	Control 1: SRP Control 2: SUPRA
Slot	2011	The Netherlands	19 (19)	SM	3 mo	SRP + Nd:YAG	SRP

CHX, chlorhexidine gel 0.5%; KTP, potassium-titanyl-phosphate laser; LLLT, low-level laser therapy; NR, not reported; PDT, photodynamic therapy; POV, povidone-iodine; SM, split mouth; SRP, scaling and root planing; SUPRA, supragingival scaling; T1 and T2, Test 1 and Test 2..

and this treatment was carried out in significantly less time.[23] The second study also compared the use of powered glycine air versus SRP with an ultrasonic device in patients with residual pockets in SPT, but evaluated the outcomes at 5 months.[24] Similarly, no significant differences between both modes of therapy were observed in clinical and microbiological outcome variables.

Endoscopic Technology

Fiberoptic endoscopic technology has been introduced in periodontal instrumentation devices with the goal of magnifying (×24–48) the interior of the periodontal pocket and thus allowing the identification and treatment of remaining calculus deposits. Only 1 RCT has investigated the additional beneficial effects of using this fiberoptic technology when performing SRP[25] and no significant differences were reported in PPD reductions between SRP alone and endoscope-aided SRP.

Lasers

Although there are more than 1000 types of laser devices, few have been used in dentistry. Depending on the laser medium and on the configuration of the optical device, each laser has different physical or biological properties.[26] The use of lasers has been proposed in the treatment of periodontitis owing to their anti-infective, physical, and ablation properties.[27,28]

Low-energy lasers do not have ablation capabilities, neither for hard or soft tissues, and their therapeutic benefit is based on reducing inflammation and enhancing the healing process.[29] This technology has not shown any efficacy in the treatment of periodontitis.

Photodynamic therapy has been proposed as an anti-infective therapy based on the property of a photosensitizer agent of absorbing light and thus becoming bactericidal.[30] This agent is activated by light with the proper wavelength, transforming oxygen to singlet oxygen and releasing free radicals that are cytotoxic to microorganisms.[31] This technology, however, does not have any capability to mechanically debride and, therefore, to remove plaque and calculus, which implies that it cannot be used as an alternative to SRP, but rather as an adjunctive therapy. There are no available RCTs assessing for this adjunctive effect.

TABLE 4. Main findings of publications on lasers

1st author	Year	Clinical variables	Main conclusion
Aykol	2011	GCF markers, SBI, PPD, CAL	The LLLT group showed SSD better clinical outcomes. No SSD could be seen for the marker levels in GCF
Braun	2010	Subjective intensity of pain, BOP	For residual pockets, the Er:YAG demonstrated less subjective pain than the sonic scaler, with no SSD for BOP
Cappuyns	2011	PPD, BOP, Recession, pain perception, microbiology (RNA probes)	PDT and SRP suppressed the microorganisms stronger and resulted in fewer persisting pockets than the diode group
De Micheli	2010	CAL, PPD, BOP, PI, microbiology (culture)	CAL gain and PPD reduction were greater in the control group
Eltas 2011	2011	CAL, PPD, GI, PI, GCF markers	SRP + Nd:YAG was more effective in reducing PPD, CAL, GI, and GCF markers
Gómez	2010	PPD, BOP, PI, GCF markers, microbiology (culture)	No SSD were found for any of the clinical or microbiological outcomes. IL-1ß and TNF-β were lower in the test group
Kelbauskiene	2011	PPD, BOP, PI, CAL, Recession	PPD reduction, CAL gain and BOP reduction were greater in the test group
Jin	2010	PPD, CAL, PI, SBI, patient perception (VAS)	No SSD were found between groups for any of the clinical outcomes. Less discomfort and treatment time in the test
Lopes	2010	PPD, CAL, Recession, GI, BOP, PI, Microbiology (PCR)	Test 1 and Control 1 showed a higher reduction for the GI. Test 1 and Test 2 presented a significant reduction in the % of sites with bacteria
Qadri	2010	PPD, PI, GI, BL(x-rays), GCF volume	PI, GI, PPD, BL, and GCF volume were lower in the test group
Qadri	2010b	PPD, GI, PI, and GCF markers	PPD, GI, PI, GCF markers, and GCF volume were lower in the test group
Romeo	2010	PI, BOP, PPD, CAL	Test 1 and Control 2 showed a greater CAL gain and PPD reduction
Rotundo	2010	PPD, CAL, PI, Recession, BOP, patient perception (VAS)	Combining SRP with Er:YAG did not obtain better results than SRP alone. Er:YAG alone obtained similar results than SUPRA
Slot	2011	PPD, PI, BOP, patient perception (VAS), microbiology (culture)	No SSD were found between groups for any of the clinical or microbiological outcomes

BL, bone levels; BOP, bleeding on probing; CAL, clinical attachment level; GCF, gingival crevicular fluid; GI, gingival index; IL, interleukin; LLLT, low-level laser therapy; PCR, polymerase chain reaction; PI, plaque index; PPD, probing pocket depths; SBI, sulcular bleeding index; SRP, scaling and root planing; SSD, statistically significant differences; SUPRA, supragingival scaling; T1 and TNF, tumor necrosis factor; VAS, visual analog scale.

Ablative lasers have been used in dentistry for both soft or hard tissue applications. In periodontal therapy, the following lasers with hard tissue ablation capability have been used and tested: semiconductor diode lasers, Er:YAG (erbium doped:yttrium, aluminium, and garnet), Nd:YAG (neodymium doped:yttrium, aluminium, and garnet), CO2 (carbon dioxide laser), and Er, Cr:YSGG (erbium, chromium doped:yttrium, scandium, gallium, garnet).[28,32-37] Since 2010, 14 published RCTs have been identified comparing lasers with conventional periodontal therapy, with all except one[29] using a split-mouth design and with follow-up evaluations ranging between 6 weeks and 12 months. **Tables 3 and 4** summarize their study design and main findings.

Although diode, Nd:YAG, and CO2 lasers have shown significant improvements in clinical outcomes and reductions[38] in subgingival microbial populations in patients with periodontitis,[26,35] when used directly on root surfaces for calculus removal they can cause excessive heat and result in root damage,[39] although with CO_2 lasers, these negative effects can be avoided when irradiating in a pulsed mode with a de-focused beam.[40] A recent systematic review has shown no beneficial effect on the use of pulsed Nd:YAG lasers when compared with conventional therapy during the initial treatment of patients with periodontitis, neither as adjunctive nor as monotherapy.[38] Similarly, 2 other systematic reviews, evaluating the efficacy of different types of lasers in nonsurgical periodontal therapy, have shown no clinical or microbiological benefits with the use of Nd:YAG laser, either as monotherapy, or as an adjunct to SRP.[41,42] In the past 2 years, 5 studies have evaluated the efficacy of Nd:YAG laser when used as adjunctive to hand or power instrumentation in the treatment of patients with chronic periodontitis.[43-47] All the studies, except one,[43] evaluated clinical outcomes and inflammatory markers in gingival crevicular fluid during periods ranging between 8 weeks

TABLE 5. Study design of publications on SRP approaches

1st author	Year	Country	n (final)	Design	Duration	Test	Control
Knöfler	2011	Germany	37	Parallel	12 mo	FMSRP: 1 session (hand + power-driven)	SRP: 2 sessions within 4-5 wk (hand + power-driven)
Pera	2011	Brazil	30	Parallel	6 mo	FMUD (1 session 45 min) + triclosan/copolymer dentifrice	FMUD (1 session 45 min) + placebo dentifrice
Santos	2012	Brazil	34	Parallel	12 mo	FMSRP: 2 sessions (2 h) within 24 h (hand + power-driven)	SRP: 4 sessions (1 h) within 21 d (hand + power-driven)
Zijnge	2011	The Netherlands	44 (39)	Parallel	3 mo	FMSRP: 1 session (3 h) (hand instruments)	SRP: 3 sessions (1 h) within 21 d (hand instruments)

FMSRP, full-mouth scaling and root planing; FMUD, full-mouth ultrasonic disinfection; SRP, scaling & root planing.

and 20 months after treatment. Two of these studies also assessed microbiological outcomes[43,45] and 1 studied patient's related outcomes.[43] In 3 of the 5 studies, the adjunctive use of Nd:YAG rendered significant clinical and anti-inflammatory benefits when compared with SRP alone.[44,46,47] In another study, only the anti-inflammatory action showed a significant benefit[45] and in the last study neither the clinical nor the microbiological and patient-related outcomes demonstrated significant differences between the treatment groups.[43]

Four studies have evaluated the use of diode laser: one used the 808-nm laser application as an adjunct to SRP with hand and ultrasonic instrumentation[29]; and 3 evaluated the 810-nm diode laser, 2 as adjunct to SRP[48,49] and 1 as mono-therapy.[50] The posttreatment evaluation periods ranged between 4 weeks and 6 months, and all evaluated clinical outcomes. Additionally, 2 studies assessed microbiological outcomes,[48,50] 1 assessed inflammatory markers,[29] and 2 assessed patient-related outcomes.[49,50] The reported results were heterogeneous, with 1 study reporting benefits for the laser group,[29] whereas in 2 studies the control group rendered better outcomes,[48,50] and in another no differences between groups were found, although patients had less discomfort in the laser group.[49]

The Er:YAG laser technology is the one that has shown higher potential for use in the treatment of periodontitis, because of its efficacy in removing subgingival plaque and calculus without significantly damaging the root surface.[51] Its clinical efficacy has been recently evaluated in 2 systematic reviews. When used as monotherapy in comparison with SRP, the meta-analysis did not reveal significant differences in clinical outcomes, both at 6 and 12 months posttreatment.[52] Similarly, the systematic review by Schwarz et al[42] demonstrated similar outcomes when evaluating RCTs comparing Er:YAG laser with SRP, although no meta-analysis could be performed. In the past 2 years, 3 RCTs using Er:YAG laser have been published. In one study, the use of Er:YAG alone was compared with a sonic scaler in the treatment of residual pockets by evaluating changes in BOP and patient-related outcomes. No differences between groups were found in terms of BOP reductions, although patients referred less pain with the use of the Er:YAG laser.[53] The other 2 studies[54,55] compared the clinical efficacy of using Er:YAG laser alone with SRP alone, or the combination of both, using as a negative control the supragingival debridement or the absence of treatment. The combination of Er:YAG with SRP did not render better clinical results than SRP alone, although this combination was significantly better than using Er:YAG alone.[54,55]

Er, Cr:YSGG lasers improve hard tissue ablation and can remove calculus without producing any visible morphologic alteration on the root surface.[56] Only 1 RCT has evaluated Er, Cr:YGG laser, as an adjunct to SRP, when compared with standard root debridement with hand and ultrasonic instruments. After 12 months, the laser group showed significant PPD and BOP reductions, as well as CAL gains.[57]

Similarly, 1 RCT evaluated the adjunctive use of a potassium-titanyl-phosphate (KTP) laser, 6 weeks after treatment, and the results showed that the combination of this type of laser with SRP (with conventional instruments) and chlorhexidine, achieved similar clinical results to those of SRP plus povidone-iodine.[58]

NEW TREATMENT PROTOCOLS IN THE NONSURGICAL THERAPY OF PERIODONTITIS

Traditionally, initial periodontal treatment was rendered in scheduled sessions (usually at weekly intervals) of SRP with either hand or ultrasonic instruments.[3] In 1995, researchers from the University of Leuven proposed the therapeutic concept of full-mouth disinfection (FMD).[59] This mode of periodontal therapy consisted of SRP of all pockets combined with the topical application of chlorhexidine, within 24 hours (usually in 2 sessions on 2 consecutive days). This

TABLE 6. Main findings of publications on SRP approaches

1st author	Year	Clinical variables	Main conclusion
Knöfler	2011	BOP, PPD, CAL, microbiology (qPCR)	FMSRP compared with SRP was not favorable in reduction of periodontopathogens.
Pera	2011	PI, GI, BOP, PPD, REC, CAL	Triclosan/copolymer-containing dentifrices can promote additional clinical benefits to 1-stage FMUD in the treatment of generalized severe chronic periodontitis.
Santos	2012	PI, SUP, BOP, PPD, CAL, GCF (ELISA)	SRP and FMSRP promoted benefits in clinical parameters and showed a similar modulation of cytokines and osteoclastogenesis-related factors at 12 months in type 2 diabetic subjects.
Zijnge	2011	PI, BOP, PPD, microbiology (PCR)	FMSRP and SRP result in overall clinically and microbiologically comparable outcomes. Recolonization of periodontal lesions may be better prevented by FMSRP.

BOP, bleeding on probing; CAL, clinical attachment level; FMSRP, full-mouth scaling and root planing; FMUD, full-mouth ultrasonic disinfection; GCF, gingival crevicular fluid; GI, gingival index; PCR, polymerase chain reaction; PI, plaque index; PPD, probing pocket depth; REC, recession; qPCR, real-time PCR; SRP, scaling and root planing; SUP, suppuration.

therapy aimed to avoid bacterial translocation to already treated sites, from other oral niches (tongue, mucosa, saliva) and from untreated periodontal pockets. This protocol has been extensively evaluated by the Leuven research group, either with the adjunctive use of antiseptics,[60-62] or without (full-mouth SRP [FMSRP]).[63,64] These studies have reported significant improvements in clinical outcomes for both FMD and FMSRP, when compared with conventional staged debridement (CSD). When this protocol has been evaluated by other research groups, significant differences with standard root debridement protocols were not achieved.[65-67] Another reported modification of this protocol, also based of the FMD concept, consisting of FMSRP in a single session with an ultrasonic device. When compared with SRP at weekly intervals using hand instruments, it has shown comparable results, although the time needed to close a pocket (reduce PPD to less than 5 mm without bleeding) was shorter with FMSRP (3.3 minutes versus 8.8 minutes).[68] This full-mouth therapeutic concept has been analyzed in 2 systematic reviews. Eberhard et al[69] included 7 RCTs using the FMD or FMSRP approach, and CSD as control, with a follow-up period of at least 3 months in patients with chronic periodontitis. Although the FMD protocol rendered higher PPD reductions compared with the CSD in sites with an initial PPD of 5 to 6 mm in single-rooted teeth, they concluded that all 3 interventions could result in improvements in clinical outcomes. Lang et al[70] assessed the clinical and microbiological outcomes of FMD or FMSRP versus CSD after a follow-up period of at least 6 months in patients with chronic periodontitis, including 12 RCTs. Although statistically significant differences favoring FMD or FMSRP were found, when compared with CSD, the authors considered these differences of small magnitude. In terms of microbiological outcomes, mainly owing to technical differences, the results from the different studies could not be compared. In summary, there was no treatment approach that could be recommended, as all 3 modalities rendered good results provided the adequate preventive measurements were achieved. Both reviews agreed that the choice of one or other treatment modality should be based on patient preferences, professional skills, logistic settings, and cost-effectiveness.

In the past 2 years, 4 further RCTs have been published.[71-74] **Tables 5 and 6** summarize their study design and main results. Two studies reported the clinical and microbiological efficacy of FMSRP when compared with CSD.[72,74] Zijnge et al[74] concluded that FMSRP and CSD did not result in different clinical outcomes (PPD and BOP) at the 3-month follow-up. Similarly, the bacterial recolonization patterns, by assessing the frequencies of detection of 5 periodontal pathogens by polymerase chain reaction (PCR) analysis, were similar between both treatment groups. Knöfler et al,[72] in a 12-month RCT, concluded that FMSRP and CSD lead to similar effects on target periodontal pathogens (*Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Tannerella forsythia,* and *Treponema denticola*), also analyzed by real-time PCR.

Santos et al[71] evaluated the potential clinical and immunological benefit of FMSRP (2 sessions within 24 hours), when compared with CSD (4 sessions within 21 days) in patients with type 2 diabetes. They concluded that both protocols were equally efficient in clinical outcomes and also showed a similar response in terms of inflammatory markers. Finally, Pera et al[73] carried out an RCT designed to assess the impact of a preventive treatment during 6 months based on the use of a triclosan/copolymer dentifrice, after 1-stage full-mouth ultrasonic debridement. The adjunctive use of this toothpaste promoted additional clinical benefits, especially in sites with initial PPD greater than 7 mm.

DISCUSSION

Despite significant advancements in our knowledge of periodontal disease pathogenesis and the factors affecting the outcome of periodontal therapy, the traditional approach of biofilm and calculus removal by root surface instrumentation continues to be the standard mode of periodontal therapy. In fact, our improved knowledge, mainly derived from biofilm research, has emphasized the importance of mechanical debridement of biofilm and calculus in the attainment of significant clinical and microbiological outcomes.

In 1996, Cobb[3] provided a good overview of the state of the art in classical mechanical nonsurgical periodontal therapy, establishing its efficacy and its limitations and providing guidelines for future research, such as the evaluation of a patient's related outcomes, cost-effectiveness, and the development of more effective instruments aimed for sites with difficult access and for reducing the operator's effort. The attainment of these goals was later evaluated in 2 systematic reviews that selected studies comparing manual versus powered instrumentation.[5,9] In both reviews, similar clinical results were attained with either manual or power-driven instrumentation and the importance of adequate calculus and subgingival biofilm debridement, together with good supragingival plaque control by the patient, was emphasized.[4]

In the VII European Workshop in Periodontology (2008), the innovations in nonsurgical periodontal therapy were extensively reviewed and critically analyzed.[2] When evaluating the advances in power-driven instrumentation[10] and the efficacy of lasers,[42] the Workshop Consensus Report concluded the following:

(1) new instruments or technologies should be evaluated in RCT, independently from the companies that produce them;

(2) clinical studies should report the working conditions of the instruments used;

(3) patient-centered outcomes are needed, such as pain or discomfort;

(4) the role of cavitation and microstreaming in removing the biofilm remain to be established.

The present evidence-based review has aimed to update the available scientific evidence in nonsurgical periodontal therapy since this European Workshop. The analysis of RCTs published in the past 2 years has further emphasized the similar clinical outcomes achieved when hand and power-driven instruments are compared. Most of the advances in the instrumentation systems tested were based on modifications of instrument tip design, as well as the use of endoscopic technology, to improve access and to remove calculus more efficiently. Although the available studies have not demonstrated a significant added value with the new instruments, they were probably not adequately designed to evaluate these enhanced properties.

The improvements in power-driven devices, mainly with the development of high-frequency piezoelectric ultrasonic units, have shown that although the attained clinical outcomes are similar when compared with either manual SRP or with conventional power-driven devices, they need less time and are softer to the patient's roots. The introduction of new ultrasonic technologies, such as the Vector system, however, did not result in improved clinical outcomes and needed longer treatment times to reach similar results when compared with conventional SRP. The advent of the Perioscan, which allows for consecutive instrumentation and calculus detection, has not been evaluated properly and we currently do not have clinical trials assessing whether the improved calculus-detection capabilities imply better clinical outcomes. The adjunctive use of improved topical anesthetic techniques, such as EMLA, improved the patient-related outcomes, because patients experienced less pain and discomfort when compared with standard modes of instrumentation. Although these results are encouraging, they are derived from a few studies with small sample sizes and short evaluation periods. There is a clear need for RCTs with adequate study designs and adhesion to the CONSORT guidelines so as to properly assess the benefits of these new technologies in periodontal instrumentation.

The most active area of research in nonsurgical periodontal therapy, in the past 2 years, has been the therapeutic use of lasers and, because there are many applications of laser in dentistry, it is important to focus on those with clear indications in the treatment of periodontitis. In general, soft tissue lasers are not able not remove dental biofilm or calculus and, hence, they should not be indicated in periodontal therapy, in spite of the many companies suggesting that diode lasers and Nd:YAG lasers are indicated as an alternative to SRP. Moreover, these applications of laser can cause unwanted thermal changes in the root surfaces or the bone when applied directly over these surfaces. The laser application that has rendered better results in the treatment of periodontitis has been the Er:YAG. Its efficacy has been proved both as monotherapy and as an adjunct to SRP, with both hand or power-driven instruments, attaining similar results to those achieved with conventional SRP. It is important to realize that when Er:YAG lasers are used as sole treatment, more time will be needed, and this time could reduced if laser is combined with a previous conventional debridement. Although the scientific evidence does not demonstrate that Er:YAG laser application achieves superiority in both clinical or microbiological outcomes when compared with conventional periodontal instrumentation, the results on patient-related outcomes have shown a clear preference by the patient for the laser application and the need for less anesthesia. Although 14 RCTs have been published in the past 2 years testing different laser applications for this clinical indication, there is still a need for further high-quality clinical research to evaluate the real capability of laser applications to remove biofilm and calculus and to ascertain the most appropriate laser application that provides better long-term clinical outcomes.

Other new technologies, such as the spray of glycine, have been proposed as an alternative to remove calculus and biofilm. The studies testing this technology were mainly focused on the treatment of residual pockets during SPT, and they showed similar results to conventional SRP, but with a better acceptance by the patients. These preliminary encouraging results indicate that the use of advance debridement technologies, such as nonabrasive powder sprays or laser applications in combination with conventional root instrumentation, may provide good long-term results with minimal disturbance for the patient. There is a need for further well-designed clinical trials to test these hypotheses.

New treatment protocols with the objective of providing enhanced clinical and microbiological outcomes in less therapeutic time have been tested in the past 2 decades. The FMD therapeutic concept, with or without the use of topical antimicrobials, has demonstrated that it is at least as effective as the conventional staged approach, although in many studies demonstrating clear benefits from the microbiological and cost-effective points of view. The conventional staged approach, however, may also have advantages in terms of attaining the appropriate motivation and efficacy in oral hygiene practices, which in many patients require treatment time and appropriate feedback and evaluation. It is, therefore, suggested that each practitioner should adopt the treatment protocol better suited for his or her needs and capabilities, as well as for the patient's needs, as the scientific evidence demonstrated that both FMD and conventional SRP, when performed correctly, and with the appropriate patient's compliance, provide similar outcomes.

CONCLUSIONS

Nonsurgical periodontal therapy is an efficacious mode of therapy for patients with periodontitis, irrespective of the instrument used or the treatment protocol performed. Many new technologies are available in the market and most have not been properly tested in clinical research, but all in general have demonstrated similar clinical outcomes to conventional SRP, with either curettes or power-driven instruments. All these new protocols and technologies, however, have shown improved patient-related outcomes and, in some, improved cost-effectiveness.

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