Nonsurgical Periodontal Treatment: Review of the Evidence

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Abstract

An increasing number of patients have become aware of the detrimental effects of periodontal disease and tooth-loss and they seek periodontal care. The cornerstone of management of chronic periodontitis is the non-surgical periodontal treatment. The primary goal of periodontal therapy is to preserve the natural dentition by achieving and maintaining a healthy functional periodontium. Many adjunctive treatment modalities have been introduced lately to enhance the therapeutic outcome of periodontal treatment. The aim of this review is to search for systematic reviews which evaluate these therapeutic modalities and discuss their efficacy. The databases of Medline via Ovid, Embase and the Cochrane Database of Systematic Reviews were searched for up to date systematic reviews in English language. The results and conclusions of the systematic reviews found in the periodontal literature are discussed in this paper. The efficacy of different oral hygiene regimens in maintaining and improving gingival health, the efficacy of the nonsurgical periodontal treatment, the full mouth disinfection, the systematic antimicrobial therapy, the local adjunctive therapies, the host modulation treatment, the Photodynamic and laser therapy are discussed. It appears that there is no certain magnitude of initial probing pocket depth where nonsurgical periodontal therapy is no longer effective. Some of the aforementioned modalities have been found to offer statistical significant benefit in clinical outcomes than the scaling and root planing alone. If this statistical significance is clinically significant needs to be critically assessed by the clinician upon the treatment planning and decision making.

Key Words: Nonsurgical Periodontal Debridement, Systematic Reviews

Introduction

Periodontitis is an infectious inflammatory destructive disease initiated by the microbial biofilm in a susceptible host. The effect of dental plaque on gingival health has been early recognised [1]. It has been well established that the dental plaque is a biofilm. A biofilm is a diverse, functioning microbial community embedded in a matrix of polymers of bacterial and salivary origin. Socransky et al. in 1998 [2] described the subgingival microflora plaque formation as a series of successive waves of colonization by increasingly periodopathogenic clusters of bacteria. The microflora shifts from Gram positive to Gram negative microbes and rods. The most pathogenic microbial cluster is the red complex which consists of the *P. gingivalis, T. Forsythia and T denticola* species [2]. The microbial- inflammatory response interface plays a major role in the occurrence of the disease. According to data from the World Health Organization (WHO), advanced disease with deep periodontal pockets (≥ 6 mm) affects approximately the 10 to 15% of the adult population worldwide [3].

The primary goal of periodontal therapy is to preserve the natural dentition by achieving and maintaining a healthy functional periodontium. It consists of patient motivation and oral hygiene instructions as well as mechanical removal of supra and subgingival plaque and calculus deposits, correction of plaque-retentive factors (eg. overhangs) and risk factor modification (eg. smoking cessation). Many terms have been used to describe this process such as nonsurgical periodontal therapy, initial periodontal therapy, hygiene phase therapy, mechanic therapy and cause-related periodontal therapy. Many adjunctive treatment modalities have been clinically used and investigated for their efficacy.

The aim of this review is to discuss the evidence behind the current clinical practice for the management of the chronic periodontal patients including oral hygiene regimens, the non-surgical periodontal treatment and the different adjunctive periodontal therapeutic modalities currently available. Systematic reviews have become the desirable method of analysing the available evidence. In this paper an effort to support the discussion referring to available systematic reviews will be made.

The databases of Medline via Ovid, Embase and the Cochrane database of systematic reviews were searched up to date. Only systematic reviews and meta-analysis in English were included. The search strategy, depicted in *Figure 1*, retrieved 278 papers. Screening of titles and abstracts was performed by the author using the following exclusion criteria: a) papers studying other forms of periodontal diseases than chronic periodontitis (e.g. aggressive periodontitis, periodontal abscesses, endo-Perio lesions etc.), b) papers referring to implant therapy or peri-implant disease, c) papers reporting therapeutic outcomes for surgical or regenerative periodontal treatment, d) papers studying the effect of periodontal treatment on gingival or systemic biomarkers. The studies selection methodology is described in *Figure 2*. Finally, 57 systematic reviews and/or meta-analysis, relevant to the aims of this review, were included for discussion.

Review Results

The main results from the review are summarised in the *Table 1*. A comprehensive discussion of the results based on the systematic reviews identified in the dental literature follows.

Oral hygiene

Tooth-brushing is the method which most if not all individuals use for their daily oral hygiene. However, it appears that most patients are unable to achieve sufficient total plaque control at each brushing. Van der Weijden and Hioe [4], in a systematic review, assessed the effect of mechanical plaque control in adults with gingivitis and concluded that the quality of self-performed mechanical plaque removal was not sufficiently effective and should be improved. From this systematic review, it appears that single oral hygiene instruction describing the correct use of a mechanical toothbrush in addition to a single

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Searches	Key words	Results
1	Periodontium/ or Gingiva/ or Periodontal Diseases/ or periodont*.mp. or Periodontitis/	77027
2	"Root Planing"/ or periodontal debridement.mp. or Periodontal Pocket/ or Ultrasonic Therapy/ or Periodontitis/ or Dental Scaling/ or Dental Plaque/ or Periodontal Diseases/ or Debridement/ or Periodontal Debridement/ or Periodontium/	73806
3	"Root Planing"/ or Chronic Periodontitis/ or non-surgical periodontal.mp.	2676
4	Dental Plaque Index/ or Mouthwashes/ or Toothbrushing/ or Gingivitis/ or Dental Plaque/ or dental plaque removal.mp. or Oral Hygiene/	36842
5	Gingivitis/ or Toothbrushing/ or Periodontitis/ or Dental Plaque/ or Metronidazole/ or Oral Hygiene/ or Chlorhexidine/ or Dental Devices, Home Care/ or Adult/	4037847
6	Chlorhexidine/ or Chronic Periodontitis/ or Anti-Infective Agents, Local/ or Dental Scaling/ or Adult/ or Periodontal Attachment Loss/ or Periodontitis/ or Periodontal Diseases/ or Periodontal Pocket/	4036664
7	antibiotics.mp. or Anti-Bacterial Agents/	324732
8	adjunct*.mp.	52908
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8	4392026
10	systematic review.mp.	40898
11	meta analysis.mp. or Meta-Analysis/	76104
12	10 or 11	101494
13	9 and 12	20856
14	Periodontal Diseases/ or Periodontitis/	35920
15	13 and 14	295
16	Limit 15 to English Language	281
17	Limit 16 to Humans	278

Figure 1. *Literature Search Strategy.*

professional session of oral prophylaxis has a significant, albeit small, positive effect on the reduction of gingival inflammation [4,5]. It also appears that in the well-motivated and properly instructed individuals who are willing to invest the necessary time and effort, manual toothbrushing and adjunctive use of interdental aids are effective in controlling plaque [4]. However, new technologies such as powered toothbrushes have been developed that may enhance plaque removal and simplify the task [4].

The powered toothbrushes have the potential to enhance both plaque removal and patient motivation. Two Cochrane systematic reviews investigated the superiority of powered toothbrushes against the manual ones and compared the efficiency of cleaning among different types of powered toothbrushes [6,7]. These reviews concluded that the powered toothbrushes with a rotation oscillation action reduce plaque and gingivitis more than manual toothbrushes and side-to-side brushes [6,7]. Recently new technologies of electric toothbrushes (e.g. sonic) have been introduced but their effect has not been systematically reviewed yet [5-7]. The results of another systematic review by Sicilia et al. are in line with the above conclusions [8]. On the other hand, Deery et al. found no evidence of a statistically significant difference between powered and manual brushes [9]. However, rotation oscillation powered brushes were shown able to significantly reduce plaque and gingivitis in both the short and long-term [9]. Contrary to the above results, Deacon et al. in a more recent Cochrane systematic review could not come to definitive conclusions regarding the superiority of one mode of powered toothbrush over any other [10]. The need of further good quality randomised controlled clinical trials was emphasized [10].

The introduction of fluoride toothpastes lead to reduction of dental caries. Addition of several agents in toothpastes aims to reduce plaque and gingival inflammation. Among them the stannous fluoride and triclosan-containing toothpastes demonstrated a better antiplaque and antigingivitis effect than conventional dentifrice [5,11,12]. There is evidence of the antigingivitis effects of 0.30% triclosan- 2.0% Gantrez copolymer dentifrice but not of those containing either soluble pyrophosphate or zinc citrate. The stannous fluoride has a statistically but marginally clinical significant evidence of antiplaque properties [13]. Slot et al. systematically reviewed the literature investigating the antiplaque and antigingivitis properties of chlorhexidine gel and dentifrice [14]. The evidence

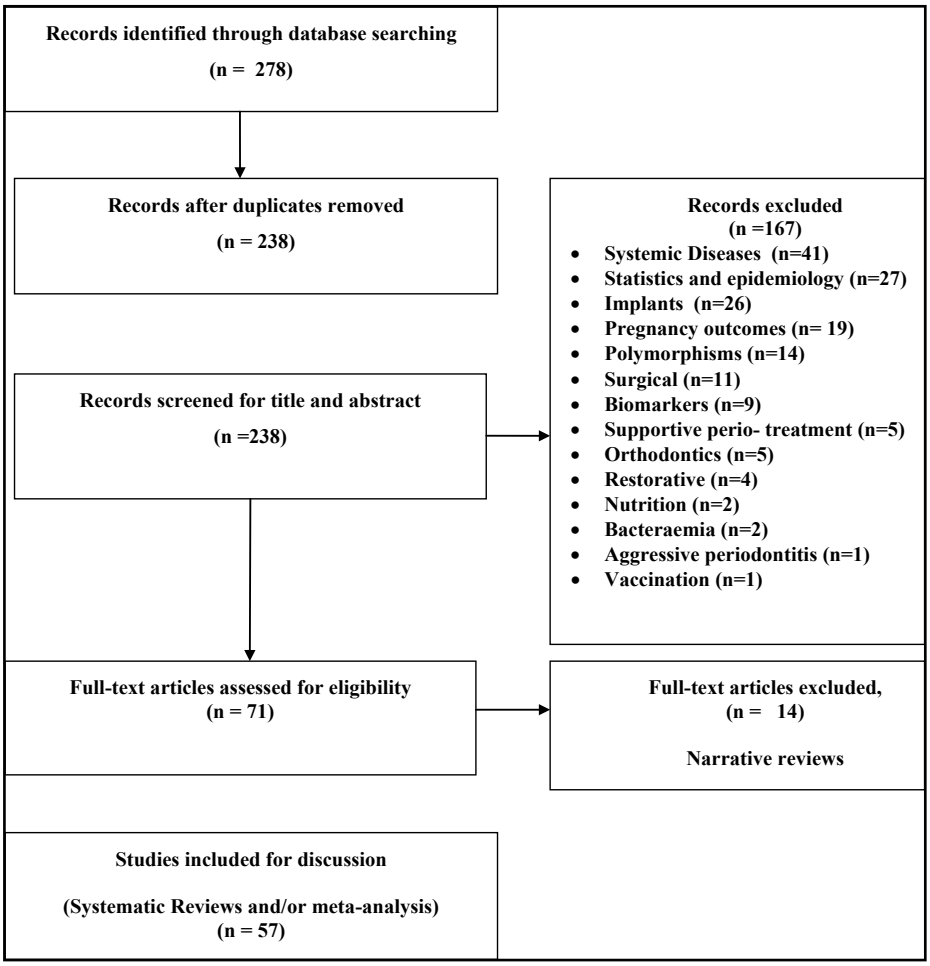

Figure 2. *Studies selection methodology flowchart.*

for the chlorhexidine gel was not conclusive. On the other hand, although brushing with a chlorhexidine dentifrice was shown to be effective, the related tooth discoloration may have a negative impact on patients' compliance [14]. Chemical plaque control has been proposed as part of an oral hygiene regimen. However, it cannot replace the mechanical self-performed plaque control. According to Gunsolley [13] who performed a meta-analysis of six-month studies of antiplaque and antigingivitis agents the largest body of studies supported the efficacy of mouthrinses with essential oils and a smaller body supported a strong antiplaque and antigingivitis effect of 0.12% chlorhexidine. The findings were inconsistent for mouthrinses containing cetylpyridinium chloride [13]. In a recent systematic review, Berchier et al. showed a small but significant plaque inhibition effect of 0.2% chlorhexidine versus the 0.12% mouthwash. However, the clinical relevance of this difference is probably negligible [15].

The Interdental cleaning is supposed to be essential to improve and maintain gingival health. The interdental areas cannot be reached by toothbrushes alone. Several aids have been used and investigated for their effectiveness such as floss, toothpicks and interdental brushes. Many dentists would confess that daily flossing is of paramount importance for maintaining good oral health. However, the ability of individuals to perform high quality flossing is questionable. There is small evidence that flossing in addition to toothbrushing reduces gingivitis but the evidence regarding plaque reduction is weak and unreliable. No evidence supports the flossing for caries prevention. Therefore, the routine instruction for daily flossing is not supported by scientific evidence and should be given only on an individual patient basis when high quality flossing could be achievable [5,16,17]. The use of woodsticks does not have an additional effect on visible interdental plaque or gingival index [18]. Interdental brushes have been shown to be the most effective interdental cleaning aids. A systematic review by Slot et al. [19]. demonstrated a significant positive difference using interdental brushes in plaque and bleeding scores and probing pocket depth. Use of interdental brushes in conjunction with brushing removes more plaque than brushing alone and brushes appear to be superior to flossing [19]. Lastly, oral irrigators is another aid proposed as adjuncts of tooth-brushing. Although there is evidence suggesting that oral irrigating reduces signs of gingival inflammation and improves gingival health, it has no beneficial effect in reducing visible plaque [20].

Periodontal instrumentation

Historically, one of the main objectives of the periodontal instrumentation was the removal of the infected cementum. Therefore, vigorous hand instrumentation and root planing was required to remove part of the cementum and achieve a glass-wise smooth root surface [21,22]. However, it was shown that microbial endotoxins are not strongly attached on the root surface and that periodontal health can be achieved without the removal of cementum by scaling and root planning [21,22]. The term periodontal debridement was suggested by Smart et al. to describe the light overlapping strokes used for instrumenting the tooth with a sonic or ultrasonic scaler [23]. Subsequently, the term has been used more broadly to describe the gentle but thorough instrumentation (by power driven and hand scaling) aiming at the removal of plaque, endotoxin and calculus but not cementum [21-23]. In vivo and in vitro studies indicate that

Table 1. *Summary of the main literature review search results.*

Study	# Studies included	Intervention	Comparator	Outcome measures	Summary
Robinson 2005 [7]	42 studies	Unsupervised power toothbrushing	Unsupervised manual toothbrushing	Plaque levels Gingival bleeding	Powered toothbrushes with a rotation oscillation action reduce plaque and gingivitis more than manual toothbrushing.
Deacon 2010 [10]	15 studies	Unsupervised power toothbrushing	Different modes of power toothbrushing	Plaque level Gingival bleeding	No definitive conclusions can be stated regarding the superiority of one mode of powered toothbrush over any other.
Slot 2008 [19]	9 studies	Interdental brushes	Toothbrushing alone or toothbrushing and flossing	Plaque scores Bleeding scores Probing Pocket Depth	As an adjunct to tooth brushing, interdental brushes are more effective in removing plaque as compared with brushing alone or the combination use of tooth brushing and dental floss.
Tunkel 2002 [26]	27 studies	Machine driven subgingival debridement	Manual subgingival debridement	Tooth loss CAL* gain PD †reduction BOP‡	The available data do not indicate a difference between ultrasonic/sonic and manual debridement in the treatment of chronic periodontitis for single-rooted teeth. Ultrasonic/sonic subgingival debridement requires less time than hand instrumentation.
Walmsley 2008 [28]	14 studies	Power driven periodontal instrumentation	Hand periodontal instrumentation	Periodontal clinical outcomes	Use of power-driven instrumentation provides similar clinical outcomes compared with hand instrumentation.
Herrera 2002 [50]	25 studies	SRP § + systemic antibiotics	SRP § alone or SRP §+ placebo	PD† reduction CAL* change	Systemic antimicrobials in conjunction with SRP § can offer an additional benefit over SRP alone in the treatment of periodontitis, in terms of CAL and PPD change, and reduced risk of additional CAL loss.
Haffajee 2003 [51]	29 studies	SRP + systemic antibiotics	SRP alone or SRP+ placebo	CAL* change	The use of systemically administered adjunctive antibiotics with and without SRP § and/or surgery appeared to provide a greater clinical improvement in CAL* than therapies not employing these agents. Guidance for the most effective systemic antimicrobial therapy not possible.
Eberhard 2008 [59]	7 studies	FMD || with or without antiseptics	Quadrant scaling	Tooth loss BOP‡ PD† reduction CAL* gain	In adults with chronic periodontitis only minor differences in treatment effects were observed between the treatment strategies.
Eberhard 2008 [60]	7 studies	FMD || with or without antiseptics	Conventional quadrant scaling	Tooth loss BOP‡ PD† reduction CAL˟gain	In patients with chronic periodontitis in moderately deep pockets slightly more favourable outcomes for pocket reduction and gain in probing attachment were found following FMD compared to control. However, these additional improvements were only modest and there was only a very limited number of studies available for comparison, thus limiting general conclusions about the clinical benefit of full-mouth disinfection.
Lang 2008 [61]	12 studies	FMD || with or without antiseptics	Conventional staged debridement (CSD)	BOP‡ PD† reduction CAL˟ gain Microbial changes	Despite the significant differences of modest magnitude, FMD || with or without antiseptics do not provide clinically relevant advantages over CSD. Hence, all three treatment modalities may be recommended for debridement in the initial treatment of patients with chronic periodontitis.
Farman 2008 [62]	7 studies	FMD|| with or without antiseptics	Conventional quadrant scaling	BOP‡ PD† reduction CAL˟gain	Mechanical debridement is an important component of treatment for chronic periodontitis and this review suggests that both the traditional quadrant approach and the newer the full-mouth debridement could be equally effective.
Cosyn 2006 [65]	5 studies	Chlorexidine chip + SRP§	SRP§ alone	PD† reduction CAL˟gain	The clinical and microbiological data currently available on the chlorhexidine chip are limited and conflicting.

Bonito 2005 [68]	Varied depending on agent (st=studies)	Local adjunctive agents: tetracycline(16 st), minocycline(8st), metronidazole(11st), a group of other antibiotics(2st), chlorhexidine(17st), and a group of antimicrobials(5st).	SRP§ alone	PD† reduction CAL˟gain	Among the locally administered adjunctive antimicrobials, the most positive results occurred for tetracycline, minocycline, metronidazole, and chlorhexidine. Adjunctive local therapy generally reduced PD† levels. Differences between treatment and SRP§-only groups in the baseline-to-follow-up period typically favoured treatment groups but usually only modestly (e.g., from about 0.1 mm to nearly 0.5 mm) even when the differences were statistically significant. Effects for CAL˟ gains were smaller and statistical significance less common. The marginal improvements in PD† and CAL˟were a fraction of the improvement from SRP§ alone.
Sgolastra 2011 [75]	3 studies	SDD¶ + SRP§	SRP§ alone	Plaque indices Gingival indices PD† reduction CAL˟gain GCF** level changes	Significant differences were observed for all investigated clinical parameters in favour of the SRP + SDD¶ group. The meta-analysis results seemed to support the long-term effectiveness of adjunctive SDD¶ therapy. However the sample size was small and future studies are required to confirm these findings.
Karlsson 2008 [76]	4 studies	Adjunctive laser therapy	SRP§ alone	BOP PD† reduction CAL˟gain	No consistent evidence supports the efficacy of laser treatment as an adjunct to non-surgical periodontal treatment in adults with chronic periodontitis. More randomized controlled clinical trials are needed.
Schwarz 2008 [77]	12 studies	Laser monotherapy	SRP§ alone	Clinical data Microbiological data Immunological data	The results from a narrative synthesis indicate that Er:YAG laser monotherapy resulted in similar clinical outcomes, both in the short and the long term (up to 24 months), compared with mechanical debridement. There is insufficient evidence to support the clinical application of either CO(2), Nd:YAG, Nd:YAP, or different diode laser wavelengths.
Azarpazhooh 2010 [79]	5 studies	Monotherapy or adjunctive photodynamic therapy (PDT)	SRP§ alone	Full mouth plaque scores Full mouth bleeding scores PD† CAL˟ Gingival recession	Photodynamic therapy as an independent treatment or as an adjunct to SRP§ was not superior to control treatment of SRP§. Therefore, the routine use of PDT for clinical management of periodontitis cannot be recommended.

*CAL: Clinical Attachment Level, †PD: Probing Depth, ǂBoP: Bleeding on Probing, §SRP: Scaling and Root Planing, ||FMD: Full Mouth Disinfection, ¶SDD: Subantimicrobial Dose Doxycycline, **GCF: Gingival Crevicular Fluid.

the loss of root substance and the roughness of root surface is less following ultrasonic than manual root instrumentation [24,25].

A systematic review of Tunkel et al. investigating the efficacy of machine driven and manual subgingival debridement failed to demonstrate any significant difference between the two methods [26]. These results are in line with those from a later systematic review by Hallmon and Rees [27]. Similarly, a more recent systematic review presented at the Sixth European Workshop of the European Academy of Periodontology concluded that the power driven instrumentation provides similar clinical outcomes compared with hand instrumentation. Nonetheless, less time is required and the ultrasonic scalers possess the ability to disrupt the biofilm not only from tip contact but also via the effects of cavitation and microstreaming. Last, antiseptic agents as coolants or irrigants were not shown to provide any additional clinical benefits [28]. A latest development in ultrasonic scaling systems is the Vector®, marketed as a pain free ultrasonic scaler. This device generates vibrations at a frequency of 25 kHz resulting in a parallel movement of the working tip to the root surface [29]. Slot et al. conducted a systematic review and concluded that the Vector® provides comparable clinical and microbiological results as power-driven and manual instrumentation in moderately deep pockets, but it is less effective in deep pockets and it requires considerably more time for calculus removal [29].

Efficacy and Expectations of nonsurgical periodontal treatment

A thorough review by Cobb [30] has been often sited regarding the expected outcomes of nonsurgical periodontal treatment in probing depth reduction and clinical attachment gain at sites that initially were 4 to 6 mm in depth or greater than 7mm. He reported mean pocket depth reduction of 1.29 mm and 2.16 mm respectively and mean gain of clinical attachment of 0.55 and 1.29 mm respectively. It needs to be noted that Cobb described a loss of attachment of approximately 0.42 mm after scaling and root planing of shallow pockets (sites with an initial probing depth of 1 to 3 mm) [30]. These findings agree with three later systematic reviews and meta-analysis [31-33].

Limitations- Drawbacks of nonsurgical periodontal instrumentation

Root sensitivity occurs in approximately half of the patients

following subgingival scaling and root planing. The sensitivity increases for a few weeks after therapy, after which it decreases [34]. The success of the nonsurgical periodontal therapy is limited when patient is not compliant, in smokers and in patients with uncontrolled diabetes. The detrimental effect of smoking in the therapeutic outcome of mechanical therapy is well established. A systematic review demonstrated that smokers do not respond as well as non-smokers with less favorable outcomes and less reduction in probing depths [35]. One of the major limitations of the nonsurgical periodontal therapy is the management of multi-rooted teeth with furcation involvement. Huyuan et al. [36]. in a systematic review assessing the 5-year survival rate of multi-rooted teeth concluded that nonsurgical conservative furcation therapy is effective in preventing degree I furcation involved teeth from further intrerradicular disease progression. However, as the lesion progresses leading to increased attachment loss, this treatment presents some limitations including incomplete calculus removal and inability of the patient to access and optimally clean the area [36].

Risk factor modification

Periodontal disease is multi-factorial in nature and recognised risk factors such as smoking and diabetes may exacerbate the severity and progression of the disease. Modification of these risk factors needs to be incorporated in the non-surgical periodontal treatment to maximize the magnitude of the response [37].

Smoking has a detrimental effect on the host immune response, both cell-mediated and humoral, in the gingivae. It suppresses neutrophil function, chemokinesis, chemotaxis and phagocytosis. Moreover, the lymphocyte, epithelial cell, fibroblast and osteoclast function is impeded [38]. It has been shown that smokers will experience less probing depth reduction than non-smokers following non-surgical periodontal treatment [35]. A recent meta-analysis assessed the effect of smoking cessation on the outcomes of periodontal therapy [39]. From the two studies included, it appears that smoking cessation leads to greater improvement in probing depth reduction and clinical attachment gain [39].

The evidence from the literature supports a bidirectional interrelationship between diabetes and periodontitis. [40]. A recent meta-analysis concluded that type-2 diabetes can be considered a risk factor for periodontitis [41]. Ryan et al. found an increased prevalence and severity of periodontitis in diabetics [42] whilst Khader et al. found that diabetics demonstrate a significantly higher severity, but the same extent of periodontal disease than non-diabetics [43]. Nonetheless, there is some evidence supporting that periodontal treatment may improve the glycaemic control [44,45]. Janket et al., however, failed to demonstrate a statistical significant decrease of the HbA1c after treatment [46]. Teeuw et al. found an improvement of glycaemic control in type-2 diabetics for at least 3 months but this conclusion should be interpreted with caution due to the heterogeneity of the included studies [47].

Systemic antimicrobial therapy

It has been suggested that root debridement alone is insufficient to eliminate bacteria found in dentine tubules, lacunae and concavities and those that have invaded the soft tissue [48,49]. It has been shown that *A. actinomycetemcomitans* resists mechanical treatment particularly well [48,49]. Therefore, systemic administration of antibiotics as adjunct to root debridement has been suggested. Several antimicrobial regimens have been suggested within the literature [48,49]. Two early systematic reviews suggested that systemic antimicrobials in conjunction with scaling and root planing offer an additional clinical benefit in probing depth reduction and clinical attachment gain [50,51]. The Sixth European Workshop of Periodontology concluded that there is no direct evidence to recommend a specific protocol for the adjunctive use of the antimicrobials [52].

The results of a meta-analysis by Hayes et al., however, did not demonstrate an additional benefit of the systemic administration of tetracycline [53]. Similarly, Elter et al. suggested that the additional benefit of the systemic metronidazole was not evident after a thirteen week follow-up period [54]. Contrary to the above findings a recent systematic review and meta-analysis seems to support the combined systemic administration of amoxicillin and metronidazole adjunctively to scaling and root planning [55]. However, due to the small number and hetereogeneity regarding dosages of the included studies, no recommendations could be made [55]. Although the cost effectiveness of this therapeutic modality, the risk of inducing bacterial resistance should be taken seriously into considerations before antibiotics are prescribed as adjuncts of the nonsurgical periodontal therapy [48,56].

Full Mouth Disinfection (FMD)

The FMD was proposed by the research group of Leuven University in 1995 as a new treatment strategy. The rationale of this approach is to eradicate or at least suppress all periodontal pathogens in a short time not only from the periodontal pockets but also the entire oropharyngeal cavity so that the recolonisation of the pockets by bacteria residing non-treated pockets and other oral sites is prevented. To achieve the above aims, Quirynen and his co-workers proposed full mouth scaling and debridement in two visits within 24 hours with additional irrigation of the pockets with 1% chlorhexidine gel, use of chlorhexidine mouthrinse and spray chairside and addition in the patients' daily oral hygiene regimen of chlorhexidine mouthwash for a period of two months to retard the recolonisation of the pockets [57].

A critical review paper co-authored by Quirynen reviewing and analysing the Leuven and other comparable studies, addressed the advantages of the FMD approach stating that the FMD concept results in significant additional clinical and microbiological improvements. Some of the advantages they proposed were the better outcome of the mechanical debridement, reduced need for surgery and more efficient treatment and time management with less overall chair-side time and less travelling or absence from work for the patient [58].

Approaches of FMD with the use of antiseptics, systemic antimicrobials or no adjunctive antiseptics were evaluated for their efficacy by other research groups and systematically reviewed. Eberhand et al. in a meta-analysis, although the number of studies was too small to drag definite conclusions, showed a statistical significant additional improvement by the full mouth approach with antiseptics [59]. However, the same author conducting a Cochrane systematic review with his co-workers concluded that although the slightly more favourable outcomes for probing depth reduction and clinical attachment gain following FMD, the improvement was considered only modest and no definite general conclusions could be drawn about the clinical benefit of FMD [60]. Similarly, the findings of Lang et al. [61] were consistent with the above Cochrane review. Lastly, Farman and Joshi [62] did not find any significant differences in clinical outcomes of the FMD with antiseptics, FMD without antiseptics and the conventional quadrant SRP concluded that all these therapeutic modalities can be equally effective [62].

Local adjuncts

Considering the risk to benefit ratio of the administration of systemic antibiotics, interest in local delivery of antiseptics and antibiotics developed. In a systematic review, analysing the effect of subgingival irrigation with chlorhexidine, no additional benefit to mechanical debridement was found [51]. In addition, the limited data currently available on the effects of subgingival chlorhexidine gel application do not also justify its use in the treatment of chronic periodontitis [63]. However, the subgingival pocket irrigation with povidone iodine demonstrated a small but statistically significant effect in probing depth reduction [64]. A commercially available bio-absorbable chip containing 2.5 mg of chlorhexidine in a cross linked hydrolysed gelatin matrix (Perio Chip) was developed and its adjunctive effect was studied in several clinical trials. According to Cosyn and Wyn [65] who conducted a systematic review, they concluded that the available clinical and microbiological data are limited and conflicting to confirm any additional value of the chlorhexidine chip [65]. Several antimicrobials in different formulations have become commercially available promising additional benefit when placed in the pockets after the mechanical debridement and in several intervals during the supportive periodontal treatment. These include tetracycline fibers, doxycycline gel, minocycline microspheres, and metronidazole gel [66,67]. A thorough systematic review by Bonito et al. [68] showed a statistical significant advantage in pocket depth reduction of 0.1 to 0.5 mm for four agents. This advantage was greatest for minocycline, followed by tetracycline and metronidazole [68]. A most recent systematic review reported a significant benefit in probing depth reduction (between 0.5 and 0.7 mm) with subgingival application of tetracycline fibres, sustained released doxycycline and minocycline but a minimal effect of chlorhexidine and metronidazole (0.1 and 0.4mm respectively) [69]. These results are in line with two earlier meta-analysis by Pavia et al. who suggested a statistical significant benefit of local tetracycline and metronidazole [70,71]. However, the clinical impact of this described statistical significant difference is limited especially if the cost of these treatments is considered [56,66,71]. Sustained release antimicrobial devices may be indicated in deep or recurrent periodontal sites [69].

Host modulation

Host modulatory therapy is a novel treatment approach which aims to downregulate destructive aspects and upregulate protective aspects of the immune response. Several agents have been used such as NSAIDS, bisphosphonates and non-antimicrobial tetracycline formulations [72]. However, the risk benefit ratio and adverse effects of NSAIDs and bisphosphonates limit their use in periodontal treatment [72]. The only currently commercially available host modulatory drug is the Periostat, a 20 mg Submicrobial Dose of Doxycycline (SDD). The two basic mechanisms of action are the inhibition of the destructive enzymes MMPs and the downregulation of key inflammatory cytokines (IL-1, Il-6 TNF-a) [72]. Two meta-analyses showed the effectiveness of this treatment modality in probing depth reduction and clinical attachment gain both in smokers and non-smokers [73,74]. A recent systematic review and meta-analysis by Sgolastra et al. supported the long term effectiveness of the adjunctive SDD treatment. However, due to the small sample size and the heterogeneity of the studies more randomised controlled trials with larger sample size are warranted to confirm the results of this therapeutic modality [75].

Laser therapy

The laser therapy has been suggested as an adjunctive or even alternative to the mechanical nonsurgical periodontal treatment. Among the advantages of laser application are the haemostatic effect, the selective calculus ablation and the bactericidal effect against periodontal pathogens. Karisson et al. [76] found that the evidence is not consistent to support the efficacy of the adjunctive laser therapy [76]. The inconsistency of the findings and heterogeneity of the available studies providing only weak evidence was stressed in another systematic review assessing the laser application as monotherapy. According to Schwarz et al. [77] the Er:YAG laser seems to possess the most suitable characteristics for nonsurgical periodontal therapy and its effects seem to be in the same range reported for conventional mechanical therapy [77].

Photodynamic therapy

Photodynamic therapy (PDT) is based on the principle that a photoactivatable substance (the photosensitizer) binds to the target cell and can be activated by light of a suitable wavelength. During this process, free radicals are formed, which then produce an effect that is toxic to the cell. Therefore as adjuncts to periodontal treatment might suppress anaerobic bacteria and other periodontopathogens residing the pockets after conventional mechanical debridement [78]. However, a recent systematic analysis including five studies with a small size sample and moderate to high risk of bias failed to indicate any superiority of the adjunct effect of photodynamic therapy. Therefore, its clinical implication cannot be recommended unless larger well designed randomised control trials demonstrate clinically significant difference [79].

Discussion – Future Potential Adjunctive Modalities

Periodontal disease negatively affects patients' quality of life impairing aesthetics, phoenetics, mastication and function, especially when it is related to tooth loss. A recent systematic review demonstrated that non-surgical therapy can moderately improve the oral-health-related quality of life (OHRQoL) [80]. Therefore, it is the dentist's ethical and legal duty of care to diagnose and manage periodontitis appropriately in line with current body of clinical evidence.

The contemporary dental clinical practice should be evidence based. Systematic reviews constitute a pivotal part of evidence based dentistry. Systematic reviews aim to synthesize the results of multiple original studies by using strategies that delimit bias [81]. In this review, an effort to discuss the relevant to the non-surgical periodontal treatment systematic reviews was made. The term ''statistical significant'' is used to report the potential superiority between the interventions under investigation. It needs to be emphasized that the terms statistical and clinical significance are not necessarily interchangeable. A statistical significant result may not be clinically meaningful. Therefore some of these results should be interpreted with caution as they may not reflect any actual clinical important benefit [69].

Behavioural change (oral hygiene and lifestyle changes eg. Smoking) is the fundament for a successful periodontal treatment and maintenance of the therapeutic outcome [82]. There was no consensus among the different systematic reviews assessing the impact of manual or powered toothbrushes on plaque removal and gingival inflammation. Although statistical significance was found favouring the rotation oscillation powered brushes, it may well be that the most important factor is the patient's education than the type of actual mechanical aid. A recent randomised controlled trial

demonstrated the importance of individualised oral health instruction and demonstration versus written or oral standardised instruction [83]. From all the interproximal aids the interdental brushes seem to be the most effective ones. Thus, addition of appropriate size brushes in the individualised oral hygiene regimen is essential [19]. Although only a limited base of evidence was available for analysis [35,39], periodontal patients should be encouraged to quit smoking as part of their overall periodontal management [39]. Nonetheless, smoking cessation at any age has been found to provide meaningful life extensions and reduce mortality [84,85].

Clinical outcomes following manual and power-driven root instrumentation have been found to be comparable [26,28]. Although an additional clinical benefit of adjunct systemic antibiotics has been described [50-52,55], it would be wise not to use this remedy routinely but only in cases of refractory or aggressive periodontitis so that the risk of developing antibiotic resistance is substantially reduced. Local antimicrobial adjuncts although considered a safe and efficacious alternative to systemic administration, the evidence for their routine use is weak [64-69]. These agents are high in cost and their indication may be limited to managing recurrent periodontal sites. The systematic reviews reporting therapeutic outcomes of the FMD, found only modest differences if any in clinical parameters. The low number of studies included did not allow general safe conclusions to be drawn [52-55].

The use of host-modulatory drugs such as the Periostat (SDD) may enhance the therapeutic outcomes. However, the small sample size of the studies included in the most recent meta-analysis makes any recommendations impossible, highlighting the need for further larger in sample good quality RCTs [75]. Lately, the use of expensive devices such as surgical and low-level lasers has been introduced in the field of periodontology. The evidence is still sparse and weak, due to the small size, the heterogeneity and the moderate to high risk of bias of the included studies, to justify their implementation in the routine non-surgical management of periodontal patients [76-79].

The seventh European workshop on periodontology discussed several biological approaches (host modulation, inflammation resolution and direct management of microbiota) as potential periodontal therapies. The Antimicrobial Peptides (AMP) can potentially kill bacteria, affect colonization, exhibit anti-inflammatory activity, bind to bacterial toxins and modulate the immune response. The probiotics have the potential to modify, at least at the short term, the oral microbiota by either direct microbiological interactions or by immune modulatory interactions. Pre-resolving mediators have to potential to enhance the bacterial clearance whilst limiting tissue damage. Lastly, nutritional modulation of periodontal inflammation by reducing caloric intake and refined sugars can potentially provide benefit to periodontal health as high caloric intake induces inflammation by either direct (post-prandial oxidative stress) or indirect (adiposity) mechanisms. The clinical implication of these approaches should be further investigated [86].

Conclusions

The nonsurgical periodontal treatment remains the gold standard for managing the periodontal patients. It can result in reduction of inflammation, pocket depth reduction and clinical attachment gain. There is no certain magnitude of initial probing pocket depth where nonsurgical periodontal therapy is no longer effective. However, it needs to be emphasized that the root instrumentation is only indicated for sites with probing depth 4mm and above as instrumenting shallow sites will potentially develop loss of attachment. Yet, no other therapeutic modality can be routinely utilized for the nonsurgical periodontal treatment than the scaling and root debridement or planing or instrumentation. The periodontal treatment is comprised of a bidirectional effort between the clinician and the patient to achieve the best therapeutic outcome. Therefore, the role of a high quality root debridement along with the implementation of a risk factor modification approach (oral hygiene habits, patient's motivation and education, smoking cessation, diabetes control, healthy lifestyle changes) in the management of periodontitis is paramount.

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