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Non-surgical management of periodontal disease

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ABSTRACT

Non-surgical removal of plaque and calculus has been part of the initial phase of the management of patients with gingivitis and periodontitis for decades. It consists of patient motivation and oral hygiene instruction as well as mechanical removal of supra and subgingival plaque deposits. The purpose of this review was to assess recent changes. The article reports on changes in our understanding of plaque as a biofilm, developments in patient plaque control, chemical plaque control and scaling instruments. It also comments on full-mouth disinfection, the use of lasers and host modulation. Modern technology has made removal of microbial deposits by the patient and dental professionals more efficient. However, other advancements need to be used in conjunction with mechanical debridement at this time.

Keywords: Dental plaque, scaling and root planing, oral hygiene, full-mouth disinfection, lasers, host modulation.

Abbreviations and acronyms: AL = attachment level; CHX = chlorhexidine; FMD = full-mouth disinfection; GEOP = generalized early-onset periodontitis; PD = probing depth; QSRP = quadrant scaling and root planing.

INTRODUCTION

The cornerstone of periodontal therapy is non-surgical management. This hasn't changed and, once disease is established in a patient, probably will not change in the future. Every patient with untreated periodontitis should undergo a course of initial or hygiene phase, as it is beneficial for all sites.[1] Patient motivation and excellent oral hygiene are vital for a successful outcome, not only in the short term, but also for the long term.[2] The success of subsequent surgical procedures depends on the standard of home care.

One of the aims of the non-surgical phase is to provide a root surface compatible with biologic reattachment, by removing plaque and calculus deposits and dealing with ''contaminated'' root surface. In addition, the clinician should also try to change modifiable risk factors, such as smoking or glycaemic control of diabetes. Non-modifiable factors, such as genetic profile, e.g., IL-1 polymorphism[3] have to be accepted, but factored into the treatment plan and expected outcomes.

The initial phase of periodontal treatment should also include removal of caries with temporary or permanent restoration depending on the prognosis of the teeth. In addition, plaque retentive factors such as restoration or crown margins, dentures and orthodontic retainers need to be addressed. Polishing of restorations and removal of staining will decrease the rate and amount of plaque build-up in subjects with good oral hygiene. Hopeless teeth should ideally be removed and endodontically-involved teeth dressed and temporized. In the experience of the author, sometimes non-surgical management is undertaken to better ascertain the patient's motivation and interest, or to gauge the prognosis of teeth, especially when deciding which teeth to extract.

Plaque is a biofilm

A fundamental change in the last decade is our understanding that plaque is a biofilm. A biofilm is a microbial community attached to an environmental surface, which is usually encased in an extracellular polysaccharide or slime matrix and forms where there is sufficient moisture and nutrients.[4] They are found in water and waste pipes, on ship's hulls, in food processing areas and on medical implants. Indwelling catheters may accumulate a biofilm. The biofilm is a 3D construction with channels allowing exchange of nutrients, transfer of genetic material and metabolites, quorum sensing and complex bacterial interaction. More importantly, it is a protected stable population. The protection provided by the glycocalyx prevents ingress of the host immune response, but also antibiotics and antiseptics. Therefore, it is necessary to

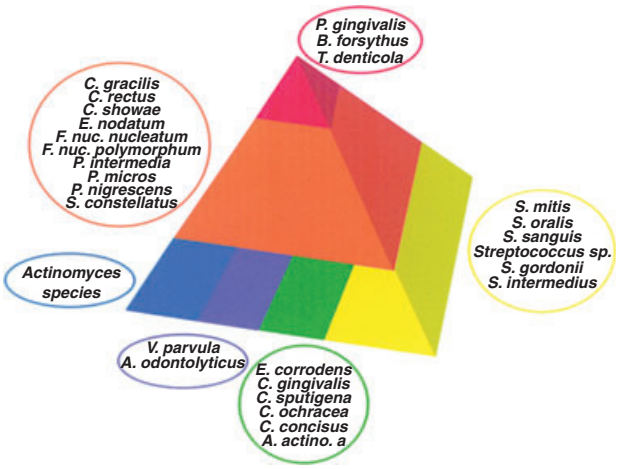

Fig 1. Each successive wave of colonization makes the foundations for the next more pathogenic group eventually resulting in the most pathogenic group, the red complex. (Diagram reproduced with permission from Haffajee and Socransky.[6])

Fig 2. Examples of the different types of toothbrushes available.

disturb the biofilm when prescribing antimicrobials to allow greater access, but also to increase the multiplication rate of the bacteria making the antibiotic much more effective.

In 1998, Socransky *et al.*[5] published what is now a seminal paper proposing that the microflora in plaque is a series of successive waves of colonization by increasingly periopathogenic bacteria, culminating in the triumvirate of *Porphyromonas gingivalis*, *Treponema denticola* and *Tannerella forsythia* (previously *Bacteriodes forsythus*). They termed this "the red group". Each group sets the scene or builds the base for the colonization by the next level and has been diagrammatically shown as a pyramid (Fig 1). It is the aim of non-surgical therapy to demolish as much of the pyramid as possible and of maintenance to keep demolishing the foundations to prevent the formation of the climax population sufficient to cause disease progression.

Personal plaque control

It has been shown beyond doubt that the accumulation of plaque leads to gingival inflammation and its removal leads to a reduction in inflammation.[7] Therefore, removal of plaque by patients is a vital part of non-surgical management. This consists of toothbrushing, interdental cleaning and chemical plaque control.

Toothbrushing

A visit to the chemist or supermarket will reveal a plethora of different toothbrushes (Fig 2). Without being flippant, the best brush is the one that gets into the patient's mouth. In 1998, the European Workshop on Mechanical Plaque Control addressed the issue of what features make an ideal toothbrush.[8] They suggested that: (1) the handle size be appropiate to user age and dexterity; (2) the head size is appropriate to the size of the patient's mouth; (3) use of end-rounded nylon or polyester filaments not larger than 0.009 inches in diameter; (4) use of soft bristle configurations; and (5) bristle patterns which enhance plaque removal in the approximal spaces and along the gum line. Many of the modern toothbrush designs fulfill these requirements.

Our patients know to brush their teeth twice a day, but most do not do this particularly well. Many different toothbrushing methods have been suggested, but none has been shown superior to another. Recently, the Bass or modified Bass technique has been in favour. One suggestion about brushing methods is to modify the patient's existing technique to make sure it is thorough, methodical and removes as much plaque as possible rather than teaching the patient a completely new technique. The frequency of brushing is traditionally twice a day. Lang *et al.*[9] showed, using a group of dentally aware subjects, that with excellent oral hygiene skills, once every 48 hours is the minimum to maintain gingival health. However, most people do not brush well, leaving substantial amounts of plaque behind.[10] An increased frequency is recommended and allows regular application of toothpastes containing fluorides or anti-plaque agents. In addition, twice daily fits much better into forming a habit than once every 48 hours.[11] The average person cleans their teeth for less time than they think. Studies have suggested that the time taken to brush one's teeth may only be about 40 seconds.[10] Based on their clinical trials research, van der Weijden *et al.*[12] suggested that two minutes brushing was the optimum for plaque removal with longer being no more effective.

Manual or powered toothbrushes

Electric toothbrushes are designed to overcome some of the limitations of manual brushing (Fig 3). They are

Fig 3. Some of the range of electric toothbrushes, cost increases from left to right.

much easier to hold and use. The rotating, oscillating or vibrating bristles and head can compensate somewhat for a patient's inadequate brushing method. Reports of the efficacy of early electric toothbrushes were carefully guarded as they did not show much, if any, superiority to manual brushes. However, developments over the last 15 years in brush design and technology have made electric brushes much more effective in plaque removal to the extent that recent studies show that they do have an advantage over manual brushing. Modern electric brushes remove more plaque and in less time than manual brushes, particularly those with small round rotating oscillating brush heads.[11]

Interdental cleaning

Toothbrushes do not clean interproximally and interdental cleaning is poorly performed by people in general.[13] Plaque accumulation, gingival inflammation and periodontal disease are more pronounced interproximally than on other surfaces.[14] There are many interdental cleaning aids available and are, most commonly, floss (or tape), woodsticks or interdental brushes (Fig 4). As with brushing, advice should be tailored to the patient and the most appropriate device for the size of the interproximal space chosen. Flossing is the most common form of interdental cleaning and is suitable when the papilla completely fills the interdental space and there is no recession. It is important to remember that floss will penetrate 2–3 mm subgingivally when used properly. If the patient cannot use floss, then other aids should be suggested. Toothpicks and interdental brushes are simple to use. Interdental brushes are most commonly cylindrical or conical and

Fig 4. Some of the plethora of interdental cleaning aids.

come in a range of sizes. The largest one that fits into the interproximal space should be chosen. Interdental brushes are also the best choice when root concavities or grooves are exposed.

Chemical plaque control

As mentioned above, many patients leave plaque behind when they clean their teeth. This has led to looking at other ways to control the plaque accumulation, especially the use of chemicals such as antimicrobials and antiseptics. A review of antibiotics is outside the scope of this article and will be ably discussed by Heitz-Mayfield later in this supplement.[15] The antiseptics are used in toothpastes, mouthwashes, sprays, gels, irrigators and varnishes. Currently, there are many different antiseptics on the market and these include bisbiguanides (chlorhexidine), quaternary ammonium compounds (cetylpyridinium chloride), phenols and essentials oil (thymol, menthol, eucalyptol, triclosan), natural products (sanguinarine, tea tree oil, sage) and oxygenating agents (hydrogen peroxide, sodium peroxyborate) (Fig 5).

Fig 5. A selection of common mouthwashes available in supermarkets and pharmacies.

Chlorhexidine is the most well known antiseptic and has been shown to be good in reducing levels of plaque and inflammation with a long substantivity. Common uses include acute conditions, trauma, post-surgery and as a short-term adjunct to oral hygiene. It has well-known side effects that normally preclude long-term use. An essential oils mouthwash has also been shown to have good reduction of plaque and inflammation, but without the side effects of chlorhexidine. In terms of sales, it is the market leader by far. As far as this author is aware, these two are the only mouthwashes in Australia that have been registered with the Therapeutic Good Administration as having a clinical effect. However, most the studies undertaken to test these products have been in a healthy population that abstained from oral hygiene procedures and their use in the management of periodontal disease is yet to be proven. Both have no long-term effect on the commensal flora and the microflora does not seem to become resistant to them. Triclosan has been used in both toothpastes, where it is particularly effective, and mouthwashes, where it has been less effective.

While the use of chemical plaque control agents in toothpaste is widely accepted by the profession, the use of mouthwashes on a regular basis is less well accepted. If a patient has a standard of oral hygiene sufficient to prevent periodontal disease then they probably do not need to use an adjunct. However, most patients do not have an optimum level of oral hygiene. This may not matter if they do not develop disease, but in those that do then an adjunct could be considered. Mouthwashes could also be used in an ''at risk'' patient to prevent periodontal disease, but currently there is no predictable method of determining who is at risk and it is unrealistic to ask all our patients to use a mouthwash on the off-chance they may develop periodontal disease. The decision to use a mouthwash is more likely to be patient choice than clinical. Mouthwashes could also be considered in patients who are medically compromised, have a handicap that prevents good oral hygiene, high-risk caries patients, orthodontic patients, and for oral malodour.[16]

Periodontal instrumentation

Traditionally scaling and root planing instruments have been divided into hand and powered instrumentation. Hand instruments include scalers, curettes, jaquettes, hoes and chisels. The classic sickle scaler (H6/H7) is designed primarily for supragingival plaque and calculus removal. The sharp pointed tip prevents much subgingival use. Curettes may be universal or area-specific. Examples of universal curettes are the Columbia 2L/2R (anterior use) and 4L/4R (posterior use) instruments. Common area-specific curettes are the series of Gracey curettes, designed for specific teeth or surfaces, i.e., 11/12 for anterior surfaces of molars and 13/14 for distal surfaces of these teeth, where they are generally more effective than universal curettes. It is important to ensure that hand instruments are sharp when used as this improves efficiency, is more likely to remove deposits rather than burnish them and reduces the amount of force used, reducing fatigue. Powered instruments are generally split into sonic and ultrasonic depending on the frequency of vibration. Sonic scalers vibrate between 3000 and 7000 Hz and ultrasonic between 22 000 and 40 000 Hz. Ultrasonic devices can be further divided into piezoelectric and magnetostrictive. In the piezoelectric scaler, an alternating current across a crystal in the handle results in a dimensional change that then makes the tip move. The movement is mainly side to side so only the edges can be used to dislodge calculus. Common brands are EMS Piezon (Electro Medical Systems, Nion, Switzerland) and NSK Varios (NSK Tech, Sydney, Australia). An alternating magnetic field in response to an electrical current causes the movement of the tip in magnetostrictive machines. The tip moves in an elliptical path and allows all surfaces to be used for debridement. Cavitron (Dentsply, Mount Waverly, Victoria, Australia) is a leading brand. Both sonic and ultrasonic scalers generate heat during use requiring a coolant, most commonly water. On units with a separate coolant supply, saline or chlorhexidine and other mouthwashes can be used, although this has no proven benefit over sterile water.[17] The coolant also acts to flush the pocket and collapsing bubbles cause cavitation. There seems to be no difference between hand and ultrasonic instruments in terms of effectiveness of debridement and the amount of tooth surface removed during use. Ultrasonic instruments have the advantage of being quicker, less fatiguing, easier to use and the flushing action of the coolant. The disadvantages may be pain and sensitivity during use, thermal damage to tooth structure, poorer tactile sensation and the creation of an aerosol. Hand instruments leave the root surface with a smooth feel, whereas ultrasonics leave a rougher, grittier surface. This seems to make no difference in the healing response.[1] Ultrasonics may also be used to remove overhanging margins of restorations.

The average width of a furcation is usually less than that of the average hand instrument.[18] In addition, the roof of the furca is usually above the level of the opening. Ultrasonics have an advantage in cleaning furca as they are usually narrower than the furcal opening. A range of curved tips designed for multi-rooted teeth is available (Fig 6).

Full-mouth disinfection

The conventional treatment of plaque-induced periodontal disease is usually debridement of the whole

Fig 6. A close-up of ultrasonic tips showing the variety available for subgingival or furcations debridement. The diamond-coated tip is used for furcationplasty.

mouth by quadrant or sextant (QSRP) over a number of visits depending on the severity. However, it has been shown that periopathogens can be transmitted intra-orally from ''uncleaned'' sites or from reservoirs such as the tongue, tonsils, cheeks and other mucous membranes.[19,20] This led Quirynen *et al.*[21] to suggest that a disinfected site may be recolonized before the completion of treatment and the concept of full-mouth disinfection (FMD). The original protocol involved full-mouth scaling and root planing within 24 hours, brushing the dorsum of the tongue for one minute with 1% chlorhexidine (CHX) gel, rinsing twice with 0.2% CHX mouthwash for one minute, subgingival irrigation three times within 10 minutes with 1% CHX gel and repeated eight days later and twice daily rinsing by the patient with 0.2% CHX mouthwash for 14 days.[21] The initial study reported the outcome in 10 patients and showed a significantly greater reduction in probing depth in the FMD group compared to the conventional protocol after two months.[21] The effect was more pronounced at deeper sites. Mongardini *et al.*[22] published a longer follow-up of up to eight months post-treatment in 24 adult and 16 generalized early-onset periodontitis (GEOP) patients, again showing that FMD was better than generalized early-onset periodontitis (QSRP). The greater outcome was due to the use of CHX, debridement within 24 hours preventing re-infection and inoculation causing an improved immune response.

Apatzidou and Kinane[23] repeated these studies in test and control groups of 20 chronic periodontitis subjects. The whole mouth of the test group was debrided within 24 hours, not using CHX, and over four visits for the control group with a follow-up for six months. They showed significant improvement in both groups, but failed to show that FMD produced a better result.[23] When the microflora was analysed they could not show that FMD resulted in greater reduction in the bacteria.[24] In a third paper, they reported both therapies were associated with a reduction in antibody titre and an increase in avidity, but no significant differences between test and control groups.[25] The only difference they reported was that the FMD group reported more post-SRP pain.[23]

More recent reports have also shown limited additional benefit of a single-visit (often just one hour) or full-mouth cleaning within 24 hours irrespective of hand or ultrasonic cleaning and choice of irrigant.[26–30] Lately, a meta-analysis and review of FMD[31] concluded, given the papers they assessed, that FMD was no more beneficial than QSRP. There are a number of issues in comparing these papers: different methodology, no or little CHX, replacement of CHX with iodine, site versus patient outcomes and differing levels of oral hygiene instruction. Therefore, it is hard to draw definite conclusions. The choice of FMD or QSRP depends on the operator, patient, time required to debride the oral cavity, cost, efficiency and post-SRP pain as both methods seem equally effective.[32] The original FMD protocol is intense and may not be realistic in private practice.

Guided pocket recolonization

A new concept from the Belgian group is guided pocket recolonization whereby health-associated bacteria are injected in pockets following SRP.[33] In a proof of principal study, Teughels *et al.*[33] tested the application of a mixture Streptococci after SRP compared to no treatment and SRP alone in a dog model. They were able to show that subgingival recolonization of periopathogens was delayed and reduced in the test groups, as well as the degree of inflammation. The application of beneficial bacteria is not new with ''probiotics'' being applied for gastrointestinal disturbances, otitis media and caries for over 40 years.[34]

Lasers in the management of periodontal disease

The use of lasers in the treatment of plaque-induced periodontal diseases is relatively recent, having first been reported in the mid 1980s. Lasers are named by the element that is stimulated to create the beam, which is collimated and of a single wavelength and colour. When the beam of photons reaches biological tissue it can be reflected, scattered, absorbed or transmitted to the surrounding tissues. Lasers possess excellent tissue ablation, bacteriocidal and detoxification properties leaving little or no smear layer and any scatter may stimulate surrounding cells improving healing. Commonly-used lasers in clinical dentistry are carbon dioxide, Neodymium:yttrium-aluminum-garnet (Nd:YAG), Erbium:yttrium-aluminum-garnet (Er:YAG), diode and gas lasers. Initially, these devices were

applied to hard tissue procedures, such as caries removal and cavity preparation. Although the early laser evaporated calculus efficiently, they caused substantial thermal damage of the underlying tooth structures. This included carbonization, microcracking, melting and resolidification of the root surface and dentine. Therefore, a laser of an appropriate wavelength that will remove calculus, but not cause thermal damage to the pulp or tooth structure should be used. The ablated surface should be compatible for reattachment of the soft tissue. The wavelength of carbon dioxide lasers is readily absorbed by water and so is a good choice for soft tissue surgery, but they produce severe thermal damage, making them unsuitable for root surface modification and calculus removal.[35] Using this type of laser at a lower energy output and with modern optic fibre delivery systems may allow its use in the future. Nd:YAG lasers are poorly absorbed by water and have much greater energy scatter into the tissues. Hence, it is very suitable for soft tissue procedures. However, use of this type in clinical studies has produced mixed results.[36] It seems that calculus may be removed completely or partially without much damage to the root surface, but a number of studies also report surface pitting, crater formation, thermal damage and production of toxic by-products. Aoki *et al.*[35] suggested the ability of Nd:YAG lasers to remove calculus is lower than the level achieved by conventional mechanical instrumentation. The Er:YAG laser is a solid state laser whose wavelength is more readily absorbed by water than others. Hydroxyapatite also absorbs this wavelength making this laser suitable to not only soft tissues, but hard tissue ablation. Using this system Aoki *et al.*[37] showed effective removal of calculus from the root surface with some surface ablation confined to cementum. Compared to an ultrasonic scaler, this same group[38] showed that the performance of the Er:YAG laser was equivalent. More recently, in a prospective study, Schwarz *et al.*[40] evaluated its use against hand scaling and root planing finding an equivalent level of subgingival calculus removal. The other types of lasers listed above have not been so well researched. Diode lasers are excellent for soft tissue surgery and have recently been developed for calculus detection in combination with a laser fluorescence probe.

In summary, the use of lasers to debride the root surface is in its infancy. It is difficult to compare the many studies in terms of protocols and types of lasers used, but in some lasers may remove some calculus and plaque to a level equivalent to that of hand or ultrasonic instrumentation. However, they show a history of significant side effects, most notably thermal damage to the root surface. Currently, there seems to be a lack of evidence supporting their use, especially given their relatively high cost.

Host modulation

Host modulation is manipulation of the inflammatory or immune response to treat disease and has been used in the management of rheumatoid arthritis, allergy and graft rejection. The host response makes a significant contribution to periodontal disease through release of inflammatory mediators, such as IL-1 and PGE_2, recruitment of pro-inflammatory cells (neutrophils and macrophages) and tissue destruction, through the matrix metalloproteinase group of proteolytic enzymes (MMPs).[39] Host modulation has been used as an adjunct to traditional periodontal therapy and consists primarily of three approaches: the anti-inflammatory effect of antibiotics, the use of non-steroidal anti-inflammatory drugs (NSAIDs) and bone-sparing agents.

Tetracycline has been shown to have an anti-inflammatory effect in clinical and animal studies treating periodontal disease reducing collagenolytic activity.[41] Minocycline and doxycycline also demonstrate this effect. Sub-antimicrobial doses of doxycycline (SDD, 20 mg twice daily), where the dose of antibiotic is below the minimum inhibitory concentration and is used solely for its anti-inflammatory effect, have been shown to provide an additional improvement over conventional therapy (SRP),[42,43] but this may not be clinically significant in smokers.[44] More recently, in a large multi-centre study of 227 patients with chronic periodontitis, Preshaw *et al.*[45] were able to show a statistically significant difference between SDD-40, a once a day SDD, compared to a placebo in the reduction in probing depth. This difference was greatest at sites of 7 mm or more where, on average, it was 0.5 mm in favour of the test group. The number and extent of the improvement at sites was significantly greater with SDD-40. At this dose there was little effect on the microflora or development of antibiotic resistance. Although statistically significant, 0.5 mm may not be clinically significant given the extra cost and time involved.

Prostaglandins are arachidonic acid derivatives which are important mediators of inflammation and PGE_2 levels in GCF have been linked to increased attachment loss.[46] NSAIDs block the production of prostaglandin through their effect on the cyclooxygenase pathway. A number of papers have reported a reduction in the amount of alveolar bone loss or gingival inflammation compared to control groups.[47–52] However, widespread use of NSAIDs has not been widely reported, perhaps due to minimal clinical advantage produced, reports demonstrating no or little effect or side effects that outweigh the benefits.

Bone sparing agents are used to reduce the amount of bone resorption by inhibiting osteoclastic activity. Both MMPs and PGE_2 are potent activators of bone resorption and their inhibition may reduce the amount

of bone loss.[53] Bisphosphonates are another group of bone-sparing agents which have been used as an adjunct to non-surgical management.[54] Lane *et al.*[55] investigated the effect of bisphosphonate therapy against a placebo as adjuncts to conventional periodontal therapy. While the test subjects experienced greater improvements in clinical parameters, the differences were statistically significant, but not clinically significant. There are also the well-known issues with patients taking bisphosphonates.[56]

The effects of scaling and root planing

On the microflora

Supragingival oral hygiene without subgingival debridement has little effect on the subgingival microflora.[57,58] However, post-SRP good oral hygiene can reduce the numbers of the periopathogenic bacteria subgingivally, but only in pockets less than 5 mm deep.[59,60] Proper supragingival oral hygiene can reduce and delay the recolonization of pockets.[61]

The advent of molecular and DNA identification methods has allowed a more exact and comprehensive evaluation of the effects of SRP on the bacterial flora, especially the red group, further confirming their role in the pathogenesis of periodontal disease. Subgingival SRP significantly reduces the prevalence and levels of pathogenic species such as *P. gingivalis*, *T. denticola* and *T. forsythia*, which correlates with a reduced probing depth (PD).[62,63] However, elimination of these species is unrealistic. In an earlier study, Christersson *et al.*[65] reported difficulty in reducing levels of *Aggregatibacter actinomycetemcomitans* (formerly *Actinobacillus*) by SRP alone in localized juvenile periodontitis patients. They needed surgery and antibiotics to achieve a good clinical result and it was suggested the ability of *A. actinomycetemcomitans* to invade tissue may account for the difficulty in reducing numbers.

On the hard and soft tissues

Eliminating all plaque and calculus from the root surface is impossible.[66] As the probing depth and furcation involvement increases, the effectiveness of SRP decreases.[67] In a recent review of non-surgical management sites of 4–6 mm PD still had 15–38 per cent of the root surface covered with deposits and those over 6 mm 19–66 per cent.[66] There were no differences between types of hand instruments or between hand and ultrasonic scaling. Traditionally, the outcome of SRP is a smooth root surface, as this equates with a ''clean'' surface and reduces microbial recolonization.[68] However, recent studies have shown no difference in the healing between smooth and rough surfaces. The root cementum is colonized by bacteria and contaminated by bacterial products, which affect the healing.[69] It recommended that as part of treatment the infected root surface should be removed to improve the response and provide a root surface compatible with soft tissue reattachment. An aggressive approach is not warranted as the infected layer can be removed by gentle scaling with hand instruments or ultrasonics and endotoxin can be removed using only a microbrush.[70] Root planing will remove all the cementum and some of the superficial dentine. The more strokes and the greater the force used the greater the loss of hard tissue.[71] The amount removed varied from 34 μm after five strokes to 343 μm after 40 strokes. Continual root planing of surfaces over a period of time may result in substantial loss of the root surface.

Oral hygiene alone results in some decrease in gingival inflammation, but the majority of the reduction in the swelling is due to subgingival debridement. This shrinkage of the gingival tissue leads to recession. The amount of recession is related to the initial probing depth with the deeper sites exhibiting more recession.[1] Coupled with the reduction in inflammation is an increase in collagen fibres in the connective tissue beneath the pocket and formation of a long junctional epithelial attachment. These result in a net decrease in PD and an increase in attachment level (AL). Molar sites tend to respond less well than single-rooted teeth, perhaps due to access issues as well furcation involvement. There is very little change in bone height at sites with horizontal bone loss.[72] Vertical defects display some infill and gain in bone height.[73] However, these changes may not be seen on radiographs.

Predicting the outcomes of non-surgical therapy

Being able to predict the outcome of the initial phase is valuable at the outset for longer-term patient treatment planning and informing the patient of the probable need for further treatment. At the reassessment visit one must also evaluate the outcome of the therapy and decide on the next phase of management. Generally speaking the more severe the disease is at outset, the poorer the outcome and the greater the likelihood of further treatment. In his 1996 review, Cobb[74] summarized the outcomes of SRP based on initial probing depths. For sites 1–3 mm deep, he noted little change in PD and a slight loss of attachment of 0.3–0.9 mm, suggesting that SRP at these sites causes more damage than good. Where the PD was 4–6 mm there was a decrease in PD of 0.7–1.25 mm and a gain in AL of 0.25–0.8 mm. At sites 7 mm+ the changes were the greatest with a reduction in PD of 1.2–2.9 mm on average and a gain in AL of 0.5–1.6 mm. In addition to the initial PD, the outcome also depends on the patient's oral hygiene, furcation involvement, root

anatomy and the patient's medical history, such as diabetes or smoking. Furcation-involved teeth do not respond as well a single-rooted teeth[75] and smokers tend to have a poorer outcome than non-smokers.[63,64] Determining the success of treatment depends on the outcome criteria. Currently, the aim is to reduce probing depths to 4 mm or below with a level of oral hygiene sufficient to maintain periodontal health. It has been shown that sites 4 mm or less can be well debrided[76] and good patient oral hygiene can influence the microflora in pockets up to 4 mm reducing the build-up of the periopathogenic microflora.[58,59] Interestingly, Badersten *et al.*[1] reported that the deeper the site, the longer it took to achieve maximal healing. Deep sites could take up to nine months for their full response to therapy and it is probable that decisions at reassessment, taken only eight weeks after the last SRP visit, have not allowed for the time taken for healing at deep sites.

CONCLUSIONS

Non-surgical management is effective in treating periodontal disease. It should always be the first therapy undertaken, but does have its limitations. Much relies on the patient's level of oral hygiene. Our understanding that plaque is a biofilm has reinforced the role of SRP as an important part of periodontal treatment. Once a biofilm has formed subgingivally, it has to be removed mechanically. Currently, the literature suggests that the use of lasers and host modulation should only be as adjuncts to physical removal of plaque and calculus. FMD is as effective as QSRP and the method chosen will be a decision between the clinican and patient, and may depend on time and cost. Replacing the pathogenic flora with a ''more friendly'' flora has just started to receive attention and may be promising. However, nothing will replace instrumentation. This hasn't changed over thousands of years and is unlikely to change in our lifetimes.

DISCLOSURE

The author has been involved in presenting educational programmes relating to oral health care products for a number of different manufacturers, but has no direct financial interest in these products or the companies which manufacture them. Products shown in the photographs were given to the author by the manufacturers.

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