

4 CEUs

# Periodontal Treatment: The Delivery and Role of Locally Applied Therapeutics

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## EDUCATIONAL OBJECTIVES

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1. Understand the onset and progression of periodontal disease.
2. Understand the objectives of mechanical therapy, its limitations and the sources of these limitations.
3. Be knowledgeable concerning available systemic and locally-delivered therapeutics, their active ingredients, delivery systems and results obtained with each of them.
4. Understand the potential advantages and disadvantages of each therapeutic option and how these should be considered when selecting the appropriate therapy for a patient.

## ABSTRACT

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The majority of adults in the United States suffer from moderate periodontal disease. Following the onset of infection, an active and progressive inflammatory process occurs. Goals of periodontal treatment include eliminating pathogens, halting disease progression and obtaining host healing and gains in clinical attachment levels. Mechanical scaling and root planing are the accepted standard treatment for periodontal disease. Challenges following mechanical treatment include how to manage and maintain plaque and microbial control. The presence of periodontal pathogens threatens the periodontal stability and health of treated sites. Systemically and locally-delivered therapeutics have been found to be effective adjunctive therapies to scaling and root planing in treating periodontal disease. Of the two methods, locally-applied antimicrobials have been found to produce higher local concentrations of the drug and lower systemic concentrations, increasing the effectiveness at the site and decreasing the risk of systemic side effects. While not eliminating bacterial resistance, the use of locally-delivered antimicrobials reduces the risk

of this occurring. Several local delivery vehicles are available for application of therapeutics, including fibers, chips, polymers and trays. In choosing a systemic or local administration, consideration should be given to effectiveness, patient compliance, ease of use, patient comfort, whether or not chairside application is required, the number of sites requiring treatment, systemic health issues or contraindications, efficiency and reliability, and clinician and patient preference.

## INTRODUCTION

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Periodontal diseases are prevalent worldwide, and while up to 15% of U.S. adults experience advanced periodontitis, the majority of adults suffer from gingivitis to moderate periodontal disease.<sup>1</sup> Periodontal disease is a host response to a pathogenic bacterial infection. Symbiotic bacteria are present at all times in a biofilm configuration, but this bacterial association changes over time with the introduction of more virulent strains. Gram negative anaerobic bacteria and other pathogens gradually increase in number and begin to alter the nature of the biofilm. Supragingival plaque contains more aerobic strains, and also acts as a bacterial reservoir for subgingival plaque.<sup>2</sup> Subgingival biofilm can develop into a community where the bacterial population is able to migrate from the sulcus region to the periodontal tissues, forming a tissue biofilm. Three to twelve weeks after biofilm formation begins, the subgingival biofilm becomes a well differentiated and structured community, containing mainly gram-negative anaerobic bacteria.<sup>3</sup> Although more than 300 species have been identified in periodontal pockets,<sup>4</sup> it is generally agreed that between 30 - 40 species are associated with periodontitis, with three bacteria – *P. gingivalis*, *T. forsythensis* and *T. denticola* – usually found in diseased sites.<sup>5</sup> Disease risk can also be assessed by measurement of the bacterial

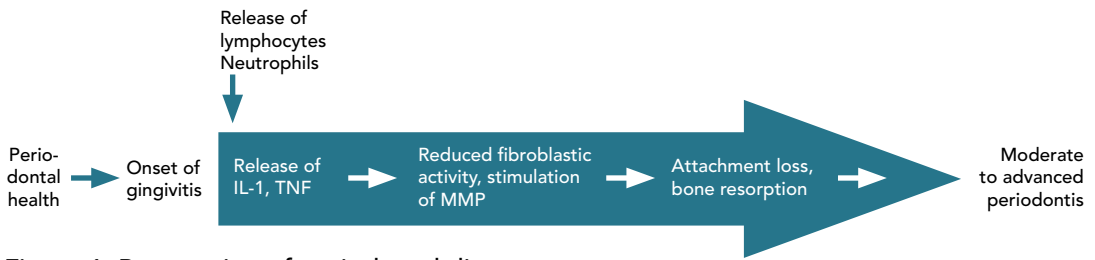


Figure 1. Progression of periodontal disease

count for these highly virulent bacteria.<sup>6</sup> While bacteria are causal for periodontal disease, their presence does not determine periodontal disease progression.<sup>7</sup> Bacterial variances are estimated to account for just 20% of periodontal disease.

## PERIODONTAL DISEASE PROGRESSION

Periodontal disease varies by age of onset, severity, whether the disease is localized or generalized, the bacteria, and the host response. Current classifications include chronic, chronic aggressive, localized aggressive and refractory periodontal disease. The host response has been identified as the primary factor determining periodontal disease progression,<sup>8</sup> and is influenced by systemic diseases, risk factors, hormones and local factors. Following the onset of gingivitis, an active and progressive inflammatory process occurs. The host response to antigens and irritants released by bacteria includes the local release of antibodies, lymphocyte and neutrophil activation and their infiltration into the gingival tissue. The activation of lymphocytes and neutrophils is defensive and involves bacterial as well as possible tissue destruction. T-lymphocytes are implicated in periodontal bone resorption as T- and B- cells derived from patients with periodontal disease induce osteoclastic activity. It has been found that differentiating factors from T cells act as receptors and increase osteoclastic activity.<sup>9</sup> The cytokines and chemokines produced by leucocytes lead to inflammation and bone loss.<sup>10</sup> Interleukin 1 (IL-1) and tumor necrosis factor (TNF) are both cytokines, and their presence results in the stimulation of matrix metalloproteinase (MMP) which is followed by attachment loss and bone resorption. TNF also reduces fibroblast activity (Figure 1).<sup>11</sup>

The host response described indicates the importance of the genetic make-up of individual patients in periodontal disease.<sup>12</sup> An example is Down's syndrome patients who have been found to have an altered immune response, with increased production of prostaglandins and MMP,<sup>13</sup> supporting the importance of the genetic component in periodontal disease progression.

Systemic diseases, hormones and risk factors have also been found to influence the progression of periodontal disease. Diabetic patients are at increased risk for periodontal disease, and have vascular abnormalities, changes in the gingival crevicular fluid and abnormal collagen activity. Changes in sex hormone levels may amplify the response to bacterial plaque and lead to gingivitis. Sex hormones are able to modify the host response, and experimental investigation suggests that increased levels of estrogen may influence the development of gingival inflammation.<sup>14</sup> Smokers account for the majority of cases of refractory periodontitis,<sup>15</sup> and smoking is regarded as a strong risk factor for periodontal disease and for poor response to periodontal treatment.<sup>16</sup>

## MECHANICAL/SURGICAL TREATMENT OF PERIODONTAL DISEASE

One of the goals of periodontal treatment is to eliminate pathogenic bacterial activity, thus halting disease progression and enabling host recovery and gains in clinical attachment levels. Mechanical scaling and root planing are considered the basic standard treatment for periodontal disease, with the objectives of eliminating periodontal pathogens, plaque, calculus and bacterial debris, and leaving smooth surfaces.

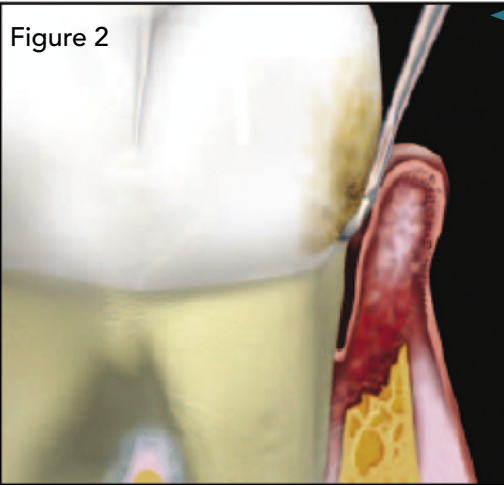
Non-surgical scaling and root planing results in the clinician working blind in a closed environment to disrupt and remove the subgingival bio-film, bacteria, debris and calculus from the root surfaces and adjacent soft tissue. In non-surgical cases, instruments may fail to instrument the base of deep pockets adequately in 75% of root surfaces, primarily due to the physical difficulties imposed by pocket morphology,<sup>19</sup> yet it is in these deeper pockets that higher levels of periodontal pathogens exist.<sup>20</sup> Surgical treatment enables the clinician to root plane under direct vision and offers more accessibility to niche areas.

Challenges following mechanical treatment include plaque and microbial retention in grooves and pockets as well as within the dentinal tubules, and the

presence of bacteria diffused in the soft tissue (Figure 2).<sup>21</sup> Dental biofilm consists of bacteria that are tightly bound to each other and a solid substrate, interspersed with fluid-filled channels. It forms a protective blanket for bacteria, reducing the effectiveness of chemotherapeutic agents and shielding bacteria from phagocytotic activity. Subgingival bacteria in biofilm that are resistant to antimicrobial therapy may also protect associated biofilm bacteria, provide diffusion barriers and modify the penetration of chemotherapeutic agents.<sup>17</sup> It has been suggested that the disruption and reduction in subgingival plaque is clinically key in treatment and that the removal of subgingival calculus is not

dentifrices, systemic antimicrobials, locally delivered antimicrobials and other therapeutics. Active ingredients used in mouthrinses and dentifrices include chlorhexidine gluconate, essential oils, fluoride, cetylpyridinium chloride, zinc citrate and triclosan. One study found that chlorhexidine, essential oils (Listerine), CPC, tetracycline and doxycycline all have anti-oxidant activity and suggested that anti-oxidative activity may be part of the mechanism of action of chemotherapeutics used in the treatment of periodontal disease.<sup>25</sup> Chemotherapeutic mouthrinses have up to 12 hours substantivity,<sup>26</sup> therefore unless rinsing is regularly performed there is no long-lasting

Figure 2



key,<sup>18</sup> however subgingival calculus provides sites for bacterial adhesion and plaque retention. The presence of periodontal pathogens threatens the periodontal stability and health of treated sites.<sup>22</sup> The periodontal pathogens may originate at the treated site, or be the result of bacterial migration from other periodontal sites or sites such as the dorsum of the tongue.<sup>23, 24</sup> Treatment failure is associated with the continued presence of, in particular, *A. actinomycetemcomitans* and *P. gingivalis*. While the host response is key in determining the progression of periodontal disease, the elimination of specific periodontal pathogens is of great importance in periodontal treatment and complete absence of these pathogens is the ideal. The use of chemotherapeutics and antimicrobials offers a method to help overcome the physical impediments and limitations of mechanical treatment of periodontal disease.

## CHEMOTHERAPEUTICS AND THE TREATMENT OF PERIODONTAL DISEASE

Chemotherapeutic products used to prevent and treat periodontal disease include mouthrinses,

### Limitations of Mechanical Therapy

- Failure of instruments to reach base of deep pockets.
- Higher levels of pathogens found in deep pockets
- Biofilm and microbial retention in grooves, pockets
- Microbial retention in dentinal tubules
- Diffusion of bacteria into soft tissue
- Migration of periodontal pathogens from other sites

effect from their use. Research on chlorhexidine gluconate has shown that after rinsing once that four days later the oral microbial composition is identical to pre-rinsing.<sup>27</sup> Chemotherapeutic rinses will penetrate the outer layers of mature biofilm,<sup>28</sup> while the innermost area of the biofilm where the most bacterial vitality is seen will be unaffected.<sup>29</sup> Additionally, it is in deeper periodontal pockets that the more virulent gram-negative anaerobic periodontal pathogens are most prevalent and it is known that mouthrinses may not reach deep into periodontal pockets.<sup>30</sup> The use of irrigators with blunt-ended cannulae, or syringes, may improve the ability of the chemotherapeutic agent to reach deeper into the site in shallow to moderately deep periodontal pockets. While useful adjuncts, chemotherapeutic rinses are subject to physical and biochemical constraints that limit their application in periodontal treatment. The crevicular flow volume is exchanged approximately 40 times in one hour, presenting a limitation for locally directed medications. This rate increases in the presence of infection, resulting in further dilution and displacement of locally delivered chemotherapeutics.

### Systemic Therapy

Antimicrobial therapy has been found to be effective in the treatment of periodontal disease, and of high value adjunctively in the treatment of aggressive periodontitis, refractory periodontitis or where the clinical outcome of treatment is potentially compromised by the patient's systemic

health. Systemic antibiotics used in the treatment of periodontal disease started with penicillin. Other antibiotics used include the tetracycline class (tetracycline, doxycycline and minocycline), erythromycin and clindamycin, and metronidazole. Tetracycline was introduced as a treatment for periodontal disease after penicillin, and its adjunctive use in addition to scaling and root planing has been found to be more effective in reducing periodontal bacteria and inflammation than either scaling and root planing or systemic antibiotic therapy alone. The choice of antibiotic (or combination of antibiotics) influences which bacteria are affected – for instance, metronidazole is highly effective against *P. gingivalis* but less effective for *A. actinomycetemcomitans*. While effective, the use of systemic antibiotics means that all body tissues are exposed to the antibiotic, while relatively low levels are available locally where they are needed. One of the outcomes of this is an increasing number of resistant bacteria strains.

**Sub-microbial levels of systemic antibiotics** were introduced in the 1990s. Doxycycline hyclate can be taken orally at submicrobial levels, 20 mg twice daily (Periostat). In this treatment regimen doxycycline's effect is a result of the inhibition of collagenase, helping to prevent the breakdown of collagen, and is not due to any anti-microbial effect. Adjunctive to scaling and root planing, it has been shown to reduce pocket depths by up to 67% and to increase clinical attachment level gain by up to 52% within 3 months in patients with severe disease.<sup>31</sup> Oral administration for 12 weeks results in reduced collagenase activity both in the gingival crevicular fluid and in extracts of inflamed gingival tissue, and no doxycycline resistance or other side effects have been found.<sup>32</sup> A further study combining the use of sub-antimicrobial levels of doxycycline with the use of a non-steroidal anti-inflammatory found that their combined use had a synergistic effect upon the suppression of matrix metalloproteinase activity.<sup>33</sup> While effective, this treatment regimen does not support bacterial elimination.

### Locally-applied therapy

The advent of local delivery vehicles has enabled local application of antimicrobials and other therapeutics over a prolonged period of time at the periodontal site(s). Delivery vehicles used include biodegradable polymers, chips, fibers and trays. Locally delivered antimicrobials have been used as stand-alone treatment and adjunctive to scaling and root planing. Locally-delivered antimicrobials include tetracycline fibers, chlorhexidine chips, doxycycline and minocycline (Figure 3).

**2.5mg chlorhexidine gluconate** (Periochip) is inserted into periodontal pockets as a thin, solid chip that consists of a biodegradable gelatin-glutaraldehyde matrix. 40% of the chlorhexidine is released within 24 hours and the remainder over the course of the 7 day treatment. Chlorhexidine gingival crevicular fluid levels are sustained at more than 480ug/ml at 3 days and have a broad spectrum antimicrobial effect.<sup>34</sup> The chlorhexidine adheres to cell wall surfaces and causes precipitation and coagulation of the cell's cytoplasm and cell death. Chlorhexidine gluconate chips have been found to be superior used adjunctively with scaling and root planing to treat deeper pockets than SRP alone. Use of chlorhexidine gluconate in dentistry has not been shown to result in bacterial resistance.<sup>35</sup>

**10% doxycycline hyclate** (Atridox) is applied with a syringe, and forms a solid biodegradable implant. The doxycycline is released for 7 days. 10% doxycycline hyclate has been found to be an effective adjunct together with scaling and root planing. In one study stand-alone use of doxycycline hyclate was as effective as scaling and root planing in reducing probing depths and in increasing clinical attachment level gain.<sup>36</sup> In comparing the effectiveness in type 1 diabetics of scaling and root planing alone or scaling and root planing and adjunctive application of 10% doxycycline hyclate gel, at the end of 12 months clinical attachment gain and reduction in probing depth were found to be significantly better in the test group in one study.<sup>37</sup> In a study on smokers, 36.8% of sites had attachment gains of 1 to 2mm versus 21.7% of sites that only received scaling and root planing.<sup>38</sup>

**25% tetracycline** (Actisite) is locally applied as a fiber and secured in place using cyanoacrylate adhesive, where it remains for 7 – 12 days. It has been shown to be effective, with greater clinical improvements used adjunctively than with scaling and root planing alone - 25% tetracycline fiber resulted in an absence of suppuration 6 weeks after treatment ended, mean probing depth reductions of 1.35mm and a significant reduction in the modified gingival index.<sup>39</sup> In a 6-month follow-up study, 25% tetracycline fiber reduced probing depth by 1.38mm versus 0.71mm for scaling and root planing alone.<sup>40</sup> At the end of a 12 month study using 25% tetracycline fibers to treat persistent periodontitis in non-smokers, there was a significant improvement with adjunctive use there were and; bleeding on probing was reduced 86.4% versus 40.9% with scaling and root planing alone. Probing depth was reduced 2.25mm versus 1.19mm and there was an attachment gain of 2.04mm versus 0.64mm. Tetracycline fiber use resulted in fewer sites

**Figure 3. Types of Therapy**

	System	Therapeutic	Application	Attributes
<b>Periochip</b>	<i>Thin, solid chip</i>	2.5mg chlorhexidine gluconate	<ul style="list-style-type: none"> <li>• 1 application</li> <li>• 7 day treatment</li> <li>• Individual sites</li> <li>• Chairside</li> </ul>	<ul style="list-style-type: none"> <li>• Biodegradable</li> <li>• Bactericidal</li> </ul>
<b>Atridox</b>	<i>Flowable polymer, syringe</i>	10% doxycycline hyclate	<ul style="list-style-type: none"> <li>• 1 application</li> <li>• 7 day treatment</li> <li>• Individual sites</li> <li>• Chairside</li> </ul>	<ul style="list-style-type: none"> <li>• Forms solid implant</li> <li>• Biodegradable</li> <li>• Bactericidal</li> </ul>
<b>Actisite</b>	<i>Fiber</i>	25% tetracycline	<ul style="list-style-type: none"> <li>• 1 application</li> <li>• 7-12 day treatment</li> <li>• Individual sites</li> <li>• Chairside</li> </ul>	<ul style="list-style-type: none"> <li>• Secured in place (cyanoacrylate to seal)</li> <li>• Bactericidal</li> </ul>
<b>Arestin</b>	<i>Microspheres, syringe</i>	1mg minocycline hydrochloride	<ul style="list-style-type: none"> <li>• 1 application</li> <li>• 14 day treatment</li> <li>• Individual sites</li> <li>• Chairside</li> </ul>	<ul style="list-style-type: none"> <li>• Bioadhesive</li> <li>• Biodegradable</li> <li>• Bactericidal</li> </ul>
<b>PerioProtect</b>	<i>Custom-fabricated trays</i>	<i>Selected by clinician</i>	<ul style="list-style-type: none"> <li>• Applied in tray</li> <li>• Daily</li> <li>• Length, duration vary (patient dependent)</li> <li>• Multiple sites/whole mouth</li> <li>• Home application</li> </ul>	<ul style="list-style-type: none"> <li>• Varies with therapeutic selected for each patient</li> <li>• Can be regularly applied as part of home care regimen for periodontal patients</li> <li>• Number of sites being treated can be varied without extending chairside or treatment time</li> </ul>

with detectable *A. actinomycetemcomitans*, *P. intermedia* and *P. gingivalis*.<sup>41</sup> A fourth study found probing depth reductions of 57.89% versus 23.68% for SRP alone and significant improvements in clinical attachment level gain after 12 months.<sup>42</sup>

In addition to their inhibitory effect on collagenase production at sub-antimicrobial levels when administered orally, and their antimicrobial effect at higher systemic doses and when locally-applied, tetracycline has also been found to have the ability to enter osteoclasts and to bind calcium. Use of locally-applied tetracycline leads to penetration into periodontal tissues and onto cementum. Tetracycline use as a pre-treatment has been found to decrease mobilization of osteoclasts, resulting in decreased osteoclastic resorption of bone.<sup>43</sup> Holmes et al found that use of tetracycline class drugs (doxycycline and minocycline) prevented osteoclast formation over 20 days when included in cell cultures.<sup>44</sup>

**Minocycline hydrochloride 1mg** (Arestin) is locally applied by syringe as microspheres in a dry powder, and remains in the pocket for 14 days. It is intended as an adjunct to scaling and root planing. The microspheres are bioadhesive and bioabsorbable, and hydrolyze upon contact with GCF, releasing minocycline within the pocket at levels substantially above the minimum inhibitory concentrations required to

kill common pathogens for more than 14 days. As an adjunct to scaling and root planing, it has been found at molar sites to result in a 27% greater pocket-depth reduction than SRP alone,<sup>45</sup> and to be effective in furcation areas. In smokers, adjunctive use of minocycline microspheres produces superior clinical results than scaling and root planing alone, with a 32% greater pocket depth reduction at 9 months.<sup>46</sup>

**Hydrogen peroxide** at concentrations under 3% has been shown over time to reduce plaque and gingivitis,<sup>47</sup> and wound healing following gingival surgery has been shown to be improved with its use topically. However, access is needed for it to be therapeutically delivered to periodontal pockets.<sup>48</sup> The levels of anti-oxidants in the gingival crevicular fluid of patients with periodontal disease have been found to be lower than in healthy patients, although it is unclear whether or not this is due to the host response.<sup>49</sup>

**Custom-fabricated trays** (PerioProtect™) are available as FDA cleared devices, to deliver antimicrobials and chemotherapeutics directly to the gingival sulcus and periodontal pocket. These devices are designed for individual patients to have variable length extensions and thicknesses – to support a seal that guides the therapeutic agent into the gingival sulcus and the periodontal pocket when the tray is

seated in place, and helps to overcome the effect of crevicular flow. Simultaneous full-mouth treatment or treatment of selected areas is possible, depending upon tray design. Over the course of treatment, tissue shrinkage during healing may result in the seal becoming ineffective, and successive trays are fabricated to ensure the appropriate fit for accurate placement of the medicament. The medicament is determined for individual patients by their dentist, and the frequency and duration of treatment can be varied. Selected medications recommended include hydrogen peroxide gel and an antioxidant (tetracycline or doxycycline). Patients were treated in one study and post-treatment results over a 6-month period were compared to the patients' pre-treatment status. A significant decrease in bleeding index and probing depth was found with the most periodontally affected teeth having a post-treatment probing depth of 3mm (+/-2.1) versus a pre-treatment probing depth of 5.7mm (+/-1.8), and post-treatment 70.8% of pockets in the severely affected group were less than or equal to 3mm probing depths post-treatment. The number of bleeding sites also decreased (20.7 +/- 14 pretreatment versus 2.7 +/- 4.4 post-treatment).<sup>50</sup> This system can be used as part of daily homecare maintenance in periodontal patients, enabling the patient to administer therapeutics at home under the direction of their dental professional. This enables repeat applications without having to visit a dental professional for the actual application. A recent study using scanning electron

microscopy and live/dead dye demonstrated bacterial death in pockets 6mm deep when therapeutics were guided into the sulcus and pockets (Figure 4).

**Considerations for selecting systemic or locally-delivered antimicrobials** include the favorably higher local availability and lower plasma levels found with locally-applied therapeutics compared to systemic delivery.<sup>51, 52</sup> For those locally-delivered antimicrobials that remain in situ for several days, controlled release maintains effective local levels and prevents the drug from being depleted too rapidly. Lower plasma levels decreases the likelihood of systemic side effects and bacterial resistance. Figure 5 shows the results of analyses comparing 10% doxycycline with oral doxycycline (200mg day one, then 100mg per day for 7 days) and 25% tetracycline with oral tetracycline (100mg per day for 10 days).

**Bacterial resistance** continues to emerge, and the widespread use of systemic antibiotics is associated with increased antibiotic resistance that represents a major health threat worldwide. In this regard, the use of actives such as chlorhexidine gluconate or hydrogen peroxide removes the issue of bacterial resistance developing. Studies have found that locally-applied antimicrobials substantially reduce bacterial resistance compared to use of systemic antibiotics. In one study comparing scaling and root planing alone, or together with adjunctive use of either locally-applied tetracycline or systemic tetracycline (500mg, bid), resistant species were lowest at 12 months in the group receiving locally-applied tetracycline fibers with a complete absence of *P. gingivalis*. *A. actinomycetemcomitans* was found to be one of the organisms showing most resistance.<sup>53</sup>

**Selective application** at specific periodontal pockets in patients with few active sites is an advantage of local delivery. However, if all periodontal sites are not treated simultaneously the periodontal pathogens from the untreated sites may re-infect the treated sites following treatment, suggesting that use of a system or product for full mouth application may be most effective. Fourmouis et al found that full mouth treatment with

Figure 4

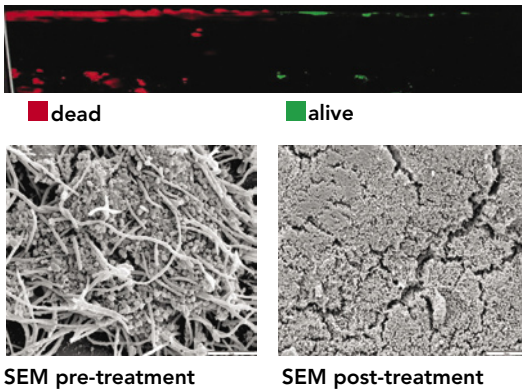


Figure 5. Anti-microbial concentrations in biological fluids

	GCF	Saliva	Serum
<b>Doxycycline — day 7</b>			
Local	148u g/ml	8.78u g/ml	<0.1u g/ml
Oral systemic	2.53u g/ml	<0.1u g/ml	0.91–2.26u g/ml
<b>Tetracycline — day 10</b>			
Local	1590u g/ml		Not detectable
Oral systemic	4–8u g/ml		</=2u g/ml

locally-applied tetracycline fiber as well as 0.1% chlorhexidine rinsing resulted in radiographically-detectable increases in bone density and alveolar bone height, and that full-mouth use resulted in a statistically significant improvement compared to site specific use of the tetracycline fiber.<sup>54</sup>

## SUMMARY

The host response is the most important determinant in the progression of periodontal disease. Since periodontal disease is of bacterial origin, persistent pathogens at periodontal sites or reinfection by periodontal pathogens result in poor treatment outcomes and renewed disease progression. Therefore, bacterial control and elimination are fundamentally important. Mechanical treatment is limited by both physical impediments, such as deep pockets where instruments cannot fully reach, and biochemical considerations. Systemically and locally-delivered therapeutics have been found to be effective adjunctive to scaling and root planing in treating periodontal disease. Locally-applied antimicrobials have been found to produce higher local concentrations of the drug and lower systemic concentrations, increasing the effectiveness at the site and decreasing the risk of systemic side effects and bacterial resistance. Currently available locally-applied antimicrobials include tetracycline, minocycline, chlorhexidine gluconate and doxycycline. Several local delivery vehicles are available for application of therapeutics, including fibers, chips, polymers and trays. Using a tray permits the clinician to use a combination of medications. In choosing a systemic or local administration, and in the case of local administrations the delivery and application method, consideration should be given to effectiveness, patient compliance, systemic health issues or contraindications, clinician and patient preference, the number of sites needing to be treated, and the therapeutic or combination of therapeutics needed for the individual patient.

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## AUTHOR PROFILE

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### Fiona M. Collins, BDS, MBA, MA

Dr. Fiona M. Collins has over 20 years of clinical, marketing, education and training, and professional relations experience. She has practiced as a general dentist for 13 years, written and given CE courses to dental professionals and students, and conducted market research projects. Dr. Collins is a past member of the Academy of General Dentistry Health Foundation Strategy Board and has been a member of the British Dental Association, the Dutch Dental Association, and the American Dental Association. In her spare time she can be found walking in the foothills of Colorado with her husband and dog, or playing music. Dr. Collins earned her dental degree from Glasgow University and holds an MBA and MA from Boston University.

### Dr. Rob Veis, DDS

Dr. Rob Veis, DDS began twenty years ago as a general dentist, and taught for twelve years at the University of Southern California as a Clinical Professor in Restorative Dentistry. He currently guest lectures at both the University of Southern California and the University of California, Los Angeles, on occlusion and appliance therapy in the general practice. Dr. Veis lectures internationally on the integration of orthodontics and appliance therapy into the general practice on behalf of Space Maintainers Laboratories where he has been a member of the teaching staff since 1990. He is coauthor of the comprehensive textbook Principles of Appliance Therapy for Adults and Children, and author of several Practice Building Bulletins. He has authored numerous articles including 'Snoring and Obstructive Sleep Apnea From a Dental Perspective', which was featured in the California Dental Association Journal and articles that were featured in the May, June and July 2003 issues of Dentistry Today.

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## QUESTIONS

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1. The majority of US adults suffers from
  - a. Only gingivitis
  - b. Moderate periodontal disease
  - c. Severe periodontal disease
  - d. None of the above
2. Supragingival plaque acts as a \_\_\_\_\_ for subgingival plaque
  - a. Barrier
  - b. Reservoir
  - c. a and b
  - d. Source of sucrose
3. Subgingival biofilm is well-differentiated \_\_\_\_\_ after biofilm formation begins
  - a. One week
  - b. Three to twelve weeks
  - c. One day
  - d. Six months
4. Bacterial variances are estimated to account for \_\_\_\_\_ percent of periodontal disease
  - a. Five
  - b. Ten
  - c. Twenty
  - d. Twenty five
5. The primary factor determining periodontal disease progression is
  - a. The amount of bacteria
  - b. The type of bacteria
  - c. The host response
  - d. All of the above
6. The host response is influenced by
  - a. Systemic diseases
  - b. Which country the patient lives in
  - c. Hormones
  - d. a and c
7. The release of lymphocytes and neutrophils is
  - a. Defensive
  - b. Destructive
  - c. a and b
  - d. None of the above
8. Smokers account for \_\_\_\_\_ percent of refractory periodontal disease
  - a. Twenty
  - b. Fifty
  - c. Eighty
  - d. Ninety
9. Periodontal treatment failure is associated with the continued presence of
  - a. *A. actinomycetemcomitans* and *P. gingivalis*
  - b. *Strep. mutans*
  - c. a and b
  - d. None of the above
10. Following mechanical treatment, microbial retention occurs in
  - a. Grooves
  - b. Pockets
  - c. Dentinal tubules
  - d. All of the above
11. Following treatment, periodontal pathogens may originate at
  - a. The treated site
  - b. The dorsum of the tongue
  - c. a and b
  - d. None of the above

12. Active ingredients used in mouthrinses and dentifrices include
  - a. Chlorhexidine gluconate
  - b. Triclosan
  - c. CPC
  - d. All of the above
13. Chemotherapeutic mouthrinses have up to \_\_\_\_\_ hours of substantivity
  - a. Three
  - b. Five
  - c. Twelve
  - d. Twenty-four
14. In mature biofilm, chemotherapeutic mouthrinses penetrate
  - a. The outer layers only
  - b. Into the middle of the biofilm
  - c. Through the biofilm to the tooth surface
  - d. None of the above
15. Systemic antibiotics used to treat periodontal disease include
  - a. Clindamycin
  - b. Tetracycline
  - c. Fluoride
  - d. a and b
16. Systemic metronidazole is highly effective against
  - a. Strep. mutans
  - b. P. gingivalis
  - c. A. actinomycetemcomitans
  - d. All of the above
17. Doxycycline hyclate taken orally, 20 mg twice daily works by
  - a. Antimicrobial activity
  - b. Inhibiting collagenase
  - c. a and b
  - d. None of the above
18. Delivery vehicles used in locally-applied therapeutics for periodontal disease include
  - a. Polymers
  - b. Fibers
  - c. Perio trays
  - d. All of the above
19. Locally-delivered antimicrobials used to treat periodontal disease include
  - a. Penicillin
  - b. Tetracycline
  - c. Doxycycline
  - d. b and c
20. A course of treatment with a 2.5mg chlorhexidine gluconate chip lasts for
  - a. 5 days
  - b. 7 days
  - c. Three weeks
  - d. Three months
21. A course of treatment with 10% doxycycline hyclate lasts for
  - a. 5 days
  - b. 7 days
  - c. Three weeks
  - d. Three months
22. A course of treatment with 10% doxycycline hyclate, as well as SRP, resulted in attachment gains of 1 to 2mm in \_\_\_\_\_ percent of sites
  - a. 21.5
  - b. 31.3
  - c. 36.8
  - d. 42.3
23. A course of treatment with 25% tetracycline fibers resulted in a reduction in probing depth after 12 months of \_\_\_\_\_ mm when used adjunctively with SRP in non-smokers
  - a. 0.4
  - b. 0.23
  - c. 2.25
  - d. 1.5
24. A course of treatment with 25% tetracycline fibers resulted in a reduction in probing depth after 12 months of \_\_\_\_\_ mm used adjunctively in non-smokers
  - a. 0.4
  - b. 0.23
  - c. 2.25
  - d. 1.5
25. Tetracycline used as a pre-treatment has been found to
  - a. Decrease mobilization of osteoclasts
  - b. Increase hormonal levels
  - c. Have no effect
  - d. Reduce the patient's energy level
26. Minocycline hydrochloride 1mg has been found in smokers to reduce pocket depth by \_\_\_\_\_ percent more used adjunctively with SRP than SRP alone
  - a. 27
  - b. 15
  - c. 35
  - d. 5
27. Custom-fabricated trays used for locally-applied therapeutics in the treatment of periodontal disease
  - a. Deliver the therapeutic directly to the gingival sulcus
  - b. Allow the clinician to choose the therapeutic and length of treatment
  - c. Have been shown to be an effective method of delivering therapeutics to reduce pocket depth
  - d. All of the above
28. The advantages of locally-delivered antimicrobials compared to systemic antibiotics include
  - a. Reduced plasma levels of the drug
  - b. Increased plasma levels of the drug
  - c. Increased levels of the drug at the periodontal site
  - d. a and c
29. If all periodontal sites are not treated simultaneously the periodontal pathogens from untreated sites may
  - a. Re-infect the treated sites
  - b. Threaten the environment
  - c. Die as a result of non-treatment
  - d. None of the above
30. Use of locally-delivered antimicrobials compared to systemic antibiotics may
  - a. Increase the patient's risk of cancer
  - b. Increase bacterial resistance
  - c. Reduce bacterial resistance
  - d. None of the above

# PERIODONTAL TREATMENT: THE DELIVERY AND ROLE OF LOCALLY APPLIED THERAPEUTICS

Name: \_\_\_\_\_

Title: \_\_\_\_\_ Specialty: \_\_\_\_\_

Address: \_\_\_\_\_ E-mail: \_\_\_\_\_

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3. Please rate the course content.

5    4    3    2    1    0

4. Please rate the instructor's effectiveness.

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5    4    3    2    1    0

6. How do you rate the author's grasp of the topic?

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Yes                  No

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\_\_\_\_\_

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