Periodontal Therapy & Maintenance: A 21st-Century Perspective

Course # 11-17
Disclosure Statement:

- The content for this self-study course was developed and written by Carol A. Jahn, RDH, MS, a Water Pik, Inc. employee.
- This course was designed, developed and produced by Water Pik, Inc.
- Water Pik, Inc., manufactures and distributes products addressed in this course.

Course Description:

To provide the dental team with general and oral health information and related research needed to help periodontal maintenance patients achieve and maintain good oral health.

Learning Outcomes:

- Discuss changing perspectives in the etiology of periodontal disease.
- Describe the role of biofilm and inflammation in disease susceptibility.
- Identify key risk factors and clinical conditions and integrate findings in oral and general health assessments.
- Evaluate the current state of the oral systemic link.
- Detail the benefits of non-surgical and maintenance therapy.
- Recommend appropriate self-care products.

INTRODUCTION

Data from 1988 to 1994 on the extent and prevalence of periodontal disease in the US population indicated that about 35% of people ages 30 to 90 had periodontal disease, with nearly 22% having a mild or moderate case and more than 12% experiencing a more severe form. Recently, a study found that these numbers might have been underestimated by as much as 50%. The new calculation used a full-mouth exam in contrast to a partial mouth evaluation, which had been used in past assessments. The findings led the researchers to speculate that more people than previously believed may suffer from moderate to severe periodontal disease.

According to the American Academy of Periodontology, the majority of people can retain teeth over their lifetime with proper treatment, reasonable plaque/biofilm control, and regular care.

As well, implants have become an ideal aesthetic and functional option for the replacement of missing teeth even for people who have periodontal disease. Successful retention of teeth and implants is contingent upon regular periodontal maintenance. It is well established that patients who participate in routine periodontal maintenance visits can prevent or minimize the recurrence of periodontal disease. Dentists and dental hygienists from general and periodontal practices working in partnership with the patient are responsible for providing the care and support to meet this goal.

PERIODONTAL DISEASE: EVOLVING THEORIES

Our understanding of the etiology of periodontal disease has progressed by leaps and bounds over the last 50 years. Early theories focused on plaque as the primary causative factor, often referred to as the non-specific plaque hypothesis. From this grew the specific plaque hypothesis, the understanding that specific types of bacteria caused the disease, not just plaque accumulation. Today, bacterial plaque has been redefined as biofilm, and periodontal disease is considered a biofilm-associated inflammatory disease caused by multiple etiologies.

Research over the last 20 years has demonstrated that the susceptibility, extent, and severity of periodontal disease are influenced by multiple factors. These factors range from genetics to environmental and also include immunological and microbial influences. Because of this range of factors, etiology likely varies from one patient to another. This means that treatment can no longer be approached as “one-size-fits-all.” Instead, the approach should be tailored to the patient’s specific risk factors.

The Microbial Influence: Biofilm

Costerton and Schaudinn note that the constant temperature, permanent moisture, and abundant and diverse nutrient supply of the oral cavity provide ideal growth conditions for more than 500 species of bacteria. Within the oral cavity, the gingival sulcus creates the conditions for a protected microhabitat. It provides protection against the tongue, saliva, and mastication. Bacteria can cling to the hard, non-shedding surface of the root. The gingival crevicular fluid and human food provide a constant source of nutrition.

Biofilm formation begins when bacteria attach and colonize a surface. They secrete a sticky, extracellular substance made up of polysaccharides, proteins, lipids, nucleic acid, and other polymers. This substance helps the bacteria stick to the surface and each other, allowing them to mature, grow, and thrive.

One way biofilm thrives is through its unique ability to function as a coordinated, spatially organized, and metabolically integrated community. Biofilm can support a broad range of bacteria, allowing oxygen-consuming and oxygen-sensitive bacteria to co-exist in close proximity. The waste products of one type of bacteria are the food source of another. Bacteria within a biofilm exhibit resistance to antibiotics. Minimum inhibitory concentrations to kill bacteria in a biofilm are 100 to 200 times higher than for planktonic cultures. Antibiotics may have difficulty penetrating the sticky extracellular matrix. Subpopulations of bacteria in a biofilm grow slower and are less susceptible to antibiotics. Additionally, the synergistic nature of the biofilm community of bacteria is likely much more pathologically virulent.
Periodontal disease has been associated with a progressive change in periodontal pathogens. “Orange complex” species like *Prevotella intermedia* and *Fusobacterium nucleatum* are commonly found in people with periodontitis. As the disease worsens, it has been shown that there is a shift to “red complex” pathogens such as *Porphyromonas gingivalis*, *Tannerella forsythia*, and *Treponema denticola*. Yet research indicates that *P. gingivalis* is frequently present in the biofilm of healthy patients. Also confounding is the discovery that some gram-negative bacteria are associated with periodontal health while a gram-positive one may be linked with disease.4

An emerging theory in the etiology of chronic disease is the “microbial shift hypothesis.” This theory posits that disease is a result of a decrease in the number of beneficial bacteria and a proliferation in the number of pathogens. Great variation in oral microflora has been observed among patients with periodontal disease. Researchers are exploring the idea that the lack of beneficial organisms in the biofilm may be as important as the presence of pathogens.4 Perhaps this is why it is well established that the presence of biofilm alone is not sufficient to cause periodontal disease.7

On the cellular level, there is some indication that bacteria evade the neutrophil challenge and stimulate the progression from an acute to a chronic inflammatory response.5 It is the chronic inflammatory process that ultimately drives connective tissue and bone loss. The expression of critical concentrations of pro-inflammatory cytokines, especially interleukin (IL)-1, 6, 11, 17; tumor necrosis factor-alpha (TNFα); and others in the gingival crevicular fluid (GCF), stimulate the chronic immune pathways.6 Of these, IL-1 has been shown to be a “master” or key cytokine mediating the production of other potent cytokines like prostaglandins. It affects many major immune processes, including cell recruitment, tissue destruction, and bone resorption.10

Another key player in the immune response is RANKL, a cytokine related to TNFα. The pro-inflammatory cytokines stimulate RANKL, which drives a process called osteoclastogenesis. In the chronic periodontal inflammatory state, RANKL enhances the production of osteoclasts while decreasing the production of osteoblasts. This process changes the balance of bone homeostasis and leads to pathological bone loss.11

There is great variation in the severity of bone loss among patients that is not explained by the amount or type of bacteria in the biofilm. This has led to the hypothesis that some individuals may be “high responders” to the periodontal infection because they produce higher levels of pro-inflammatory mediators. It has been demonstrated that patients with severe periodontal disease have higher levels of IL-1β in all probing depth areas, including shallow pockets. This suggests that the expression of IL-1β may be a host or genetic trait.12

Genetic Influences

Not every individual is susceptible in the same way to the same amount of biofilm and/or bacteria. Experimental gingivitis studies from the 1970s found that even in the absence of oral hygiene for 21 days, some individuals did not develop gingivitis, while others had substantial inflammation within two weeks. The differences in gingivitis susceptibility were independent of both a quantitative difference in plaque accumulation and a qualitative difference in plaque content.13

A study of 117 pairs of adult identical (64) and fraternal (53) twins found that about 50% of the variability in disease expression had a genetic basis. The differences in probing depth and attachment loss were not attributable to behaviors such as smoking, oral hygiene habits, or utilization of dental services. Identical twins were more similar in disease expression than fraternal twins. This genetic variance was related to both severity and extent of disease. The researchers concluded that about half of the variance in disease expression in the population is based on heritability.14

In 1997, Korman and colleagues identified a genetic marker associated with the increased production of IL-1β.15 During the

**Immunoological Influences: Inflammation**

The immune response to bacteria and/or infection is essential in fighting disease. The swelling, inflammation, and bleeding symptomatic of gingivitis are the hallmark of an acute inflammatory response to bacterial biofilm. Early gingivitis has been shown to develop within two to four days of new biofilm growth. From days four to ten, the immune response heightens, including loss of connective tissue collagen. Within two to three weeks, the lesion progresses with additional connective tissue loss and fibrosis but no attachment or bone loss. In some individuals, this stage of gingivitis may be present for years without developing into periodontitis.9

While most people develop some type of local or generalized gingivitis at some time during their lives, not everyone develops periodontal disease. The reason for this is not completely known.
A current cigarette smoker is four times more likely to have periodontal disease than an individual who has never smoked. Regular cigar and pipe smoking also have been shown to be detrimental to periodontal health. Studies indicate that smokers are more likely to have deeper probing depths, greater attachment loss, more bone loss, and fewer teeth. There is often more calculus but less inflammation. A dose-response relationship between smoking and periodontal disease has been observed, with the heaviest smokers having increased disease severity. Younger adult smokers (19-30 years) often have a higher prevalence and severity of periodontitis than young non-smokers. The “periodontal cost” of smoking has been calculated as 27 years of disease progression. This means that a 32-year-old smoker has similar periodontal attachment loss to a 59-year-old non-smoker.  

Smoking has been shown to impact the immune response. Systemically, nicotine impairs the function of neutrophils, including phagocytosis, and reduces salivary and serum IgG. Locally, GCF concentrations of nicotine have been shown to be 300 times that of plasma nicotine concentrations. Nicotine can bind to the root surface, altering fibroblast attachment while decreasing collagen and increasing collagenase production. Fibroblasts exposed to nicotine produce higher amounts of pro-inflammatory mediators, including IL-1 and IL-6. Not only does smoking increase the extent and severity of periodontal disease, it compromises the outcomes of surgical and non-surgical therapy. Overall, the data indicate that probing depth reduction and clinical attachment gain in smokers is 50%-75% of that observed in non-smokers. Smoking has also been associated with implant failure and impaired outcomes in regenerative therapy.  

When patients quit smoking, the rate of bone and attachment loss slows, and evidence indicates that disease severity is intermediate to that of current and non-smokers. Importantly, former smokers have been shown to respond to both surgical and non-surgical therapy similarly to never-smokers. Implant success rates are also similar to those of never-smokers. People who have diabetes are about three times more likely to have periodontal disease than people without diabetes. Glycemic control plays a large role, with adults who have the poorest control exhibiting a greater prevalence and severity of inflammation and attachment loss. Both adults and children with diabetes have been shown to exhibit more gingival inflammation than those without diabetes. Periodontal destruction may start early in life for children with diabetes and become more pronounced in adolescence. Data has shown that in children and young adults with diabetes, 13.6% of those aged 13-18 years and 39% of those aged 19-32 years have periodontitis.  

The way that diabetes impacts the periodontium is similar to the way it induces other diabetic complications. Diabetes has been shown to alter the immune response by impairing neutrophil adherence, chemotaxis, and phagocytosis. At the same time, there is evidence of a hyper-responsive monocyte/macrophage phenotype leading to increased production of pro-inflammatory mediators in the GCF. The level of cytokines in the GCF have been shown to correspond to glycemic control. Patients with poor control have been found to have GCF levels of IL-1β twice the level of people with good glycemic control. It is believed this increased amount of IL-1β may play a role in the increased
The evidence on response to therapy for patients with diabetes is limited. It has been observed that, over a five year period, people with diabetes who have good or modest control responded to surgery and periodontal maintenance in a similar fashion to people without diabetes. Patients who have poor glycemic control seem to have a more rapid recurrence of periodontitis and less favorable long-term outcomes.\textsuperscript{21}

The following recommendations were made: it may increase the risk for CVD. In regard to patient information, periodontal disease increases the systemic inflammatory burden, acknowledge that because untreated or inadequately controlled from the editors of the \textit{Journal of Periodontology} note that it is reasonable to note that it is reasonable to acknowledge that because untreated or inadequately controlled periodontal disease increases the systemic inflammatory burden, it may increase the risk for CVD. In regard to patient information, the following recommendations were made:

### THE LINK BETWEEN ORAL AND SYSTEMIC HEALTH: INFLAMMATION

For more than 20 years, dental researchers have observed, studied, and been confounded by data linking poor oral health to cardiovascular disease (CVD), adverse pregnancy outcomes, diabetes, and other health conditions. Once promising relationships foundered in light of newer evidence. Studies seemed to generate more questions rather than answers. Researchers have begun to understand that the association between oral and systemic health has a very complex theme: inflammation.\textsuperscript{24} Additionally, scientists have noted that chronic diseases like CVD and type 2 diabetes take years to develop; thus, it may be challenging for a short-term intervention, such as scaling and root planning (SRP), to have a significant impact on systemic health.\textsuperscript{25} Likewise, adverse pregnancy outcomes may stem from multiple ongoing factors and treatment during pregnancy may come too late.\textsuperscript{26}

#### Cardiovascular Disease

Numerous studies on the link between CVD and periodontal disease have been conducted. Outcomes have ranged widely, some showing no relationship and others finding strong evidence for a causal connection. Due to this variation in findings, at present, a direct causal relationship between these two chronic conditions has not been established. Furthermore, to date, while some studies have shown that the treatment of periodontal disease may reduce some of the systemic markers of inflammation and/or endothelial function, none have evaluated CVD outcomes, such as a reduction in risk of stroke or heart attack.\textsuperscript{24}

This ongoing discrepancy in outcomes leaves many clinicians confused about how to counsel patients. A Consensus Report from the editors of the \textit{American Journal of Cardiology} and the \textit{Journal of Periodontology} note that it is reasonable to acknowledge that because untreated or inadequately controlled periodontal disease increases the systemic inflammatory burden, it may increase the risk for CVD. In regard to patient information, the following recommendations were made:

<table>
<thead>
<tr>
<th>Periodontal Condition</th>
<th>CVD Risk Factors</th>
<th>Recommendation</th>
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<tbody>
<tr>
<td>Moderate to severe</td>
<td>None</td>
<td>Informed that there may be an increased risk for CVD associated with periodontitis</td>
</tr>
<tr>
<td>Moderate to severe</td>
<td>One known major risk factor (Smoking, family history, high cholesterol)</td>
<td>Informed that they should consider a medical evaluation if they have not had one in the last 12 months</td>
</tr>
<tr>
<td>Mild, moderate, or severe</td>
<td>Two or more known major risk factors (see above)</td>
<td>Referred for a medical evaluation if they have not had one in the last 12 months</td>
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An example of the complexity in the association between CVD and periodontitis is found in a 2005 study by Beck and Offenbacher. They analyzed the relationships between periodontal pathogens, antibody response to the pathogens (level of immune response), and clinical signs of periodontal disease. Four distinct patterns emerged. People with few pathogens and a low immune response had the best overall and periodontal health. Those with low pathogens and a high immune response had early periodontal disease and were more likely to be males > 65 with a history of CVD, thick carotid arteries, heart attack, or stroke. A third group had high pathogens but a low immune response. This group consisted mainly of females < 65 years with severe periodontal disease. They were most likely to be current smokers but with little CVD. The final group had high pathogens and a high immune response. Overall, they had severe periodontal disease and numerous health issues, including hypertension, obesity, and diabetes. In light of the results, the authors noted that the relationships were complex and possibly subgroup-specific.\textsuperscript{25}

#### Adverse Pregnancy Outcomes

Early studies on the influence of periodontal disease on adverse pregnancy outcomes focused on the impact of periodontitis on preterm birth and/or the incidence of low birth weight. Two seminal studies in 1996 and 2001 demonstrated that periodontal disease significantly increased these risks.\textsuperscript{27,28} Subsequent intervention studies compared SRP during pregnancy to treatment post-delivery. Like the work on CVD, the results provided a wide variation in outcomes.\textsuperscript{29,30}

A December 2010 meta-analysis of 10 of the highest-quality intervention trials conducted between 2002 and 2010 revealed that treatment of periodontal disease during pregnancy prevented neither preterm birth nor low birth weight. Data was available on preterm birth and low birth weight for 6,142 and 5,829 subjects,
respectively. In contrast, a March 2009 meta-analysis of seven studies (2,663 subjects) conducted between 2002 and 2007 found that SRP significantly reduced the incidence of preterm birth and was borderline significant in preventing low birth weight. The authors of this paper noted that their results might be premature and cited three ongoing trials, all of which were included in the 2010 analysis. The investigators also found that SRP was most effective in women who did not have a history of preterm birth or low birth weight and in those with less severe periodontitis.

In a 2009 study, Offenbacher et al. noted that at this juncture it is impossible to know whether or not periodontal disease causes preterm birth or if the issue is that periodontal therapy cannot prevent preterm birth. They propose that it is possible that both preterm birth and periodontal disease share a common, underlying condition, such as an exaggerated inflammatory response. Another prevailing hypothesis is that treatment may be more effective pre-conception or between pregnancies than it is during pregnancy. The data seem to indicate that SRP does not contribute to preterm birth, nor is it associated with any cognitive, motor, or language development problems in children born to mothers treated during pregnancy.

Diabetes

While it is well established that diabetes increases the risk for periodontal disease, investigators over the last several years have begun to examine the effects of periodontal infection on the glycemic control of people with diabetes. A groundbreaking study by Grossi et al. (1997) found that SRP plus doxycycline led to an improvement in glycemic control for three months. By six months, levels had returned to baseline. Three meta-analyses on the effect of periodontal treatment on glycemic control (A1C) have been conducted since 2005. The first, by Janket et al., reviewed 10 intervention studies (456 subjects) and determined that periodontal therapy produced no significant reduction in A1C levels. In 2008, Darre et al. analyzed nine studies (485 subjects) and found that periodontal treatment caused a significant reduction in A1C. Likewise, in 2010, Teeuw et al. found evidence of improved glycemic control for at least three months in patients with type 2 diabetes. This review included five studies (382 subjects). However, both Darre and Teeuw advise caution in interpreting the results. Both note that the results were not robust and that the design of the some of the studies was deficient.

CLINICAL CONSIDERATIONS

Implants, occlusion, and defective restorations may present oral hygiene cleaning challenges affecting gingival health. Over the last 30 years, implants have become a mainstream therapy for the replacement of lost teeth, with 300,000-428,000 placed annually in the US. The American Association of Orthodontists notes that one in five orthodontic patients is an adult. Many patients have crowns, bridges, veneers, and other restorations that may be older or in need of replacement.

Dental Implants

With a success rate of 90% or higher, implants are an ideal choice for the replacement of missing teeth. A history of periodontal disease is not a contraindication. Failure occurs in a small percentage of patients. Implants that do fail are often lost before loading while those that have been in place for 10 years or more are least likely to fail. The same risk factors, such as smoking and diabetes, that predispose an individual to periodontal disease also put them at risk for implant failure. The data indicate that a history of periodontal disease and/or lack of regular maintenance visits influence implant failure. Implants placed in the pre-molar or molar area of the maxilla seem to be a greater risk for failure. Lee et al. found that people with a history of a periodontal infection were more likely to have colonies of the red complex pathogens P. gingivalis and B. forsythus (now T. forsythia) around their implants. Zupnik et al. found that males have higher implant failure rates than females. They attributed this difference to oral hygiene factors as data has indicated that women brush their teeth more frequently than men and have a higher prevalence of dental visits.

Orthodontics

Orthodontic therapy is becoming more common in adults of any age. Treatment may range from site-specific to full-mouth appliances. A history of periodontal disease is not necessarily a contraindication for orthodontic treatment, as long as the disease has been arrested. In some instances, orthodontic therapy may be indicated for a periodontal patient, especially if poor occlusion seems to be a contributing factor to bone loss. Properly aligned teeth make good oral hygiene easier.
There is little reliable evidence on the effects of orthodontic therapy on periodontal health. During treatment, appliances may make daily cleaning more difficult, leading to an increase in bleeding and inflammation. Tooth movement or bands that reach subgingivally may increase the risk for alveolar bone loss. One systematic review found that orthodontic treatment was associated with small increases in gingival recession (0.03 mm), bone loss (0.13 mm), and pocket depth (0.23 mm) post-treatment. At the practice level, these changes would be difficult to detect through standard probing.

Restorations
Aging crowns and other restorations may have open or overhanging margins that act as inviting reservoirs for bacterial biofilm. Costerton and Schaudinn note that an opening of less than 0.5 mm can become a protected microhabitat for bacteria. Lang et al. found that individuals with healthy gingiva developed bleeding and harbored periodontal pathogens after receiving a restoration with a 1-mm proximal overhanging margin. Paolantonio et al. studied systemically healthy non-smoking adults who received three class V restorations in three different materials: amalgam, glass ionomer cement, and composite resin. Over a one-year observation period, they found that none of the materials increased the amount of plaque biofilm, bleeding on probing, or pocket depth. However, the sites with composite resin experienced a microbial shift, with increases in gram-negative anaerobic bacteria and lower gram-positive aerobic counts.

TREATMENT CONSIDERATIONS
The successful treatment and maintenance of periodontal disease including implants requires professional therapy followed by regular maintenance visits and diligent self-care. The type of initial and follow-up treatment required is patient-specific and influenced by disease severity, presence of risk factors, and medical and dental history. These factors may be taken into consideration when recommending an appropriate self-care product. Also, dexterity, motivation, and product interest are equally important considerations.

Practitioners typically measure initial success via surrogates, such as reductions in plaque biofilm/bacteria, bleeding on probing, and pocket depth. In the long term, success may mean preventing tooth loss, maintaining stability of the periodontal condition, and preventing recurrence. For patients, success may include retention of teeth as well as other criteria, such as comfort, appearance, and ability to eat the foods they enjoy.

Initial Therapy
Initial therapy often includes a non-surgical phase and a surgical phase. Non-surgical therapy is traditionally considered SRP and may also be called periodontal debridement. A review by Suvan on the effectiveness of non-surgical therapy found that this type of treatment reduces inflammation and pocket depth, and increases clinical attachment gain. Heitz-Mayfield compared non-surgical therapy to surgical therapy and found that non-surgical therapy was better in improving clinical attachment in pockets 6 mm or less while surgical therapy was better in reducing pocket depth in areas 4 mm and greater.

It is well accepted that hand and ultrasonic instrumentation are similarly effective tools for SRP. Many practitioners use a combination of both modalities. Ultrasonic instrumentation provides a time-efficient option. In recent years, lasers have been used for SRP. Current evidence on the effectiveness of lasers is limited; comparisons are challenging due to the varying types. At present, there is minimal evidence supporting the use of a laser as a monotherapy for subgingival debridement or as an adjunct to SRP.

Local delivery agents are a common adjunct to SRP. Various types of antimicrobials have been used, including tetracycline, minocycline, and chlorhexidine (CHX). All agents have shown modest yet consistent results in reducing probing depth, typically about 0.5 mm. Results for clinical attachment have generally been smaller. Of the three agents, minocycline appears the most promising with regard to probing depth reduction and clinical attachment gains.

Maintenance Therapy
Periodontal maintenance is essential for helping patients prevent or reduce the incidence of disease recurrence. The interval basis for maintenance visits may vary depending on the specific needs of the patient. Suvan found that mechanical debridement during periodontal maintenance reduced inflammation, disturbed biofilm, and contributed to stability in probing depth and clinical attachment level. Hujoel et al. found that patients who participated in periodontal maintenance at least once yearly for three years reduced the rate of tooth loss by half compared to people who did not come for maintenance visits.

Regular maintenance visits are necessary to maintain tissue health around an implant. Routine probing is controversial. It can be difficult to obtain accurate readings due to design of the
prosthesis. Aggressive probing may create a bleeding. If bone loss or any pathology is suspected, measurements should be taken with a plastic probe. Plastic or titanium instruments are recommended to remove biofilm and/or calculus around an implant, as they are less likely to scratch the abutment. An ultrasonic with a plastic or carbon-composite tip may also be used. For polishing, a non-abrasive prophy paste (Figure 1) is recommended. Air polishing is an option, but must be used with caution. Repeated use over time has been shown to cause some alteration in the implant surface. Used improperly, trauma can result in tissue emphysema.

**SELF-CARE**

Daily oral hygiene consisting of tooth brushing and interdental cleansing is critical in maintaining periodontal health and preventing recurrence of disease. The manual toothbrush is the most common and often the only means of daily self-care used by many people. Power toothbrushes (Figure 2) have become more widely used in the last twenty years. Due to brush-head speed, design, and bristle configuration, power toothbrushes have the potential to remove more biofilm than a manual brush. Yet almost everyone needs some type of interdental cleaner to prevent gingivitis and periodontal disease.

**Interdental Cleansing**

The American Dental Association has found that 32.9% of adults utilize floss or other types of interdental cleaners daily. Dental floss is the most common recommendation, yet it is the most difficult for patients to master. Interdental brushes, toothpicks, wooden sticks, floss aids/holders, automatic flossers, and Water Flossers are alternatives that have been compared favorably to string floss.

Few studies have examined the benefit of adding string floss to tooth brushing. A systematic review of the efficacy of dental floss in addition to tooth brushing on biofilm and gingival inflammation did not find a significant benefit. Eleven studies of a minimum of 28 days were included in the review. Four studies showed that the addition of flossing resulted in greater biofilm reduction. For measures of inflammation, only one study had superior results for the reduction of bleeding.

Systematic reviews have been conducted on interdental brushes and wooden sticks. Slot et al. reviewed nine studies and found that interdental brushes remove more biofilm than dental floss. There was no difference between the products in reduction of gingival inflammation. The Hoenderdos et al. review of wooden sticks included eight studies. The results showed that wooden sticks did not have an additional effect on the reduction of plaque or gingivitis, but it did improve the bleeding tendency.

**Water Flosser/Oral Irrigation**

The Waterpik® Water Flosser (Figure 3) has been compared to string floss in three studies. In each case, the Water Flosser was found to be significantly more effective in reducing bleeding. With regard to biofilm, two studies that utilized either the Classic Jet Tip (Figure 4) or the Plaque Seeker Tip (Figure 5) removed biofilm similarly to string floss. A study involving the Orthodontic Tip (Figure 6) removed three times as much biofilm as manual brushing and flossing together, and five times as much as brushing alone.

Numerous studies have shown that periodontal maintenance patients who added a pulsating Water Flosser to tooth brushing had significantly better reductions in bleeding and/or gingivitis over tooth brushing alone. A systematic review by Husseini et al. supports these findings. Notably, Flemmig et al. found that over a six month period, periodontal maintenance patients reduced bleeding by 50%. Jolkovsky et al. found that periodontal patients who used the Pik Pocket™ Tip (Figure 7) with either water or 0.04% CHX had significant reductions in gingivitis and...
Cutler et al. assessed traditional clinical measures and inflammatory cytokines in their study of periodontal patients. Not only did daily use of the Water Flosser with plain water reduce bleeding and gingivitis, it reduced IL-1β. The measurement was taken eight hours post-use. Even though tooth brushing both alone and with the Water Flosser reduced biofilm, only the group that used the Water Flosser reduced IL-1β.

A study conducted at the University of Southern California Center for Biofilms, using scanning electron microscopy, evaluated the effect on biofilm of a three-second pulsating (1,200 per minute) Water Flosser lavage at medium pressure. The results showed that the Water Flosser removed 99.9% of the biofilm (Figures 8 & 9). In 1988, prior to the awareness of plaque as a biofilm, Cobb et al. observed that the Water Flosser with water disrupted the fibrin-like material of subgingival plaque and reduced the quantity and quality of pathogens up to 6 mm. Similarly, Drisko et al. found that the Water Flosser reduced spirochete counts up to 6 mm, and Chaves et al. demonstrated that a Water Flosser with either 0.4% CHX or water reduced subgingival bacterial counts while tooth brushing or 0.12% CHX rinsing could not.

Diabetes

People with diabetes tend to have more inflammation and therefore need meticulous daily self-care. The Water Flosser has been shown to be a safe and effective device for reducing inflammation in people with diabetes. People with diabetes who added the Water Flosser to routine oral care had a 44% better reduction in bleeding and a 41% better reduction in gingivitis compared to routine oral hygiene.

Implants

Implants represent a significant oral health investment. Regular, thorough daily self-care to remove biofilm is critical in maintaining implant health. The Water Flosser is an ideal tool for people with implants. Many people with implants have a history of periodontal disease. The Water Flosser has been shown to reduce periodontal pathogens and reduce bleeding and inflammation in people in periodontal maintenance. Felo et al. compared 0.06% CHX irrigation to 0.12% CHX rinsing on implants. They found that CHX irrigation reduced bleeding, gingivitis, and calculus formation better than rinsing: 62% versus 33% for bleeding and 45% versus 10% for gingivitis. The study by Felo et al utilized the Pik Pocket™ Tip. The Plaque Seeker® Tip with its three thin tufts of bristles is also a good choice for implants.

SUMMARY

New discoveries in biofilm, host response, risk factors, implant placement, and the oral systemic link continue to drive change and refinement in the treatment of periodontal disease. Self-care has evolved as well, offering more options for individualized interdental cleansing. More people than ever will retain their teeth through regular professional care and good daily oral hygiene.
References

1. New information suggests that the incidence of periodontal disease may have been underestimated by as much as ___.
   a. 20%
   b. 35%
   c. 50%
   d. 68%

2. Within the oral cavity, the ____________ allows for a protected bacterial microhabitat.
   a. Tongue
   b. Gingival sulcus
   c. Molars
   d. Salivary glands

3. ______ has been shown to be a “master” or key cytokine mediating the production of other potent cytokines.
   a. IL-1
   b. TNFα
   c. PGE2
   d. INFγ

4. About _____ of the variance in disease expression in the population is based on heritability.
   a. A quarter
   b. A third
   c. Half
   d. Three-fourths

5. A current cigarette smoking habit makes a person ____ times more likely to have periodontal disease than an individual who has never smoked.
   a. 2
   b. 4
   c. 6
   d. 8

6. People with diabetes who have poor glycemic control often have:
   a. More gingival inflammation and attachment loss
   b. Greater incidence of caries
   c. Malocclusion
   d. Good oral health

7. A patient with periodontal disease and 2 or more known major risk factors should be:
   a. Informed that there may be an increased risk for CVD associated with periodontitis
   b. Advised to have a medical evaluation if they have not had one in the last 12 months
   c. Referred for a medical evaluation if they have not had one in last 12 months
   d. Not treated until they have had a medical evaluation

8. Treating periodontal disease during pregnancy:
   a. Has not been shown conclusively to reduce the incidence of preterm birth
   b. Has not been shown to contribute to preterm birth
   c. Has not been associated with any cognitive, motor, or language development problems in the children born to mothers treated during pregnancy
   d. All of the above

9. Which factors predispose a patient to implant failure?
   a. Smoking and alcohol consumption
   b. Obesity and diabetes
   c. Smoking and diabetes
   d. Obesity and alcohol consumption

10. Non-surgical periodontal therapy has been shown to be effective in:
    a. Reducing inflammation
    b. Reducing probing depth
    c. Increasing clinical attachment
    d. All of the above

11. Patients who participated in periodontal maintenance at least once yearly for three years reduced the rate of tooth loss by _____.
    a. 20%
    b. 30%
    c. 50%
    d. 70%

12. ________ instruments are recommended to remove biofilm and/or calculus around implants, as they are less likely to scratch the abutment.
    a. Plastic or titanium
    b. Stainless steel
    c. Gold
    d. Rubber latex

13. A systematic review of 11 studies on the efficacy of dental floss in addition to tooth brushing on plaque and gingival inflammation found:
    a. Four studies showing better biofilm removal
    b. One study showing a better reduction in bleeding
    c. Both a and b
    d. None of the above

14. The Water Flosser has been compared to string floss in ____ studies and in each case was found to be significantly more effective in reducing bleeding.
    a. 0
    b. 2
    c. 3
    d. 4

15. A three-second pulsating (1,200 per minute) Water Flosser lavage at medium pressure removed ____ of biofilm from treated areas.
    a. 39.9%
    b. 49.9%
    c. 79.9%
    d. 99.9%
CE REGISTRATION FORM AND ANSWER SHEET

Course #11-17: Periodontal Therapy & Maintenance: A 21st-Century Perspective

Name: ____________________________

Credentials: ________________________

Street Address: ______________________

City: ________________________________

State/Province: _____________________

Zip/Postal Code: ______________________

Email: ______________________________

Day Phone: __________________________

Cell or Home Phone: __________________

Answer Sheet
Please circle the correct answer for each question.

1. a b c d
2. a b c d
3. a b c d
4. a b c d
5. a b c d
6. a b c d
7. a b c d
8. a b c d
9. a b c d
10. a b c d
11. a b c d
12. a b c d
13. a b c d
14. a b c d
15. a b c d

Course Evaluation
Circle your response: 1 = lowest, 5 = highest

Course objectives were met
1 2 3 4 5

Content was useful
1 2 3 4 5

Questions were relevant
1 2 3 4 5

Rate the course overall
1 2 3 4 5

How did you acquire this course:
Internet  Tradeshow  Lunch & Learn  Other____

Scoring:
In order to receive credit, you must answer 10 of the 15 questions correctly.

Questions regarding content or applying for credit?
Email: ce@waterpik.com

To submit Answer Sheet by email or mail:
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• Answers left blank will be graded as incorrect.
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• The post-test may be submitted via mail or email to:
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  1730 East Prospect Road
  Fort Collins CO 80553
  Attn: Continuing Education Self Study Program
  Email: ce@waterpik.com

  • Results will be sent via email within 8 weeks, if answer sheet is mailed or e-mailed.

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