

# Dental Caries: A Biofilm Disease

By V. Kim Kutsch, D.M.D.



Biofilms are found in nature wherever there is a fluid, a surface and bacteria. Biofilms are found lining waterlines, oil pipelines, on river rock and the surfaces of living creatures. Biofilms may be symbiotic or they may be harmful and cause damage. Recently, the biofilms found lining waterlines inside dental units have been a source for water contamination and have been a concern for the dental profession. Biofilms are now recognized as a highly organized and very sophisticated community of multiple species of bacteria with a functional infrastructure. The biofilm consists of about 85 percent structure and 15 percent bacteria. Bacteria that exist in a planktonic form undergo major genetic changes as they become sessile and exist in the biofilm. In the biofilm environment, the bacteria switch on/off up to 85 genes

and behave so differently that they almost appear to be different species. The biofilm has a rudimentary circulatory system, metabolic and waste channels, and the bacteria communicate with each other and even share genetic material.<sup>1</sup> Not surprisingly, bacteria in a biofilm are up to 1,000 times more resistant to antibiotics, antibiotics and antimicrobial agents. The best treatment for a pathogenic biofilm is mechanical debridement, a strong oxidizing agent and heat.

We now recognize dental plaque as a sophisticated biofilm. This biofilm develops rapidly on the teeth and forms a protective coating that reduces wear and maintains ionic stability with the enamel surface that supports the demineralization/remineralization process maintaining the integrity of the enamel. In a normal, healthy mouth, the

biofilm begins development immediately with precipitation of salivary proline-rich, casein-micelle globules. Calcium ions bridge between the globules and within two hours, streptococcus bacteria adhere to the pellicle with exopolysaccharides and form a multilayered protein structure. Pioneering species generally include *S. sanguis*, *gordonii*, with co-aggregation of *A. naeslundii*. The biofilm then becomes anaerobic, consisting of multiple bacterial species and achieves structure and function. This climax community may be only



Figure 1. High-risk patient with high active caries process.

25–100 microns thick, and may develop in 24 hours and be stable for long periods.<sup>2</sup> While it is generally assumed that “clean” teeth do not decay, normal brushing and flossing does not remove this pellicle or thin biofilm. The presence of thick plaque does not necessarily result in cavitation, and a clean appearing tooth may have a cariogenic biofilm.<sup>3</sup>

Under certain conditions, the normal, healthy biofilm may become replaced with a cariogenic biofilm that causes cavitation of the enamel and tooth decay. Dental caries is now recognized as a biofilm disease. In a normal biofilm, acidogenic/aciduric bac-

See Page 20



Your office is the smile that greets your patients.

How is your “office smile?”

If it needs a better look, **Bnk Construction** can help. We specialize in dental and medical tenant improvements, with over 40 successful remodels in the last four years.

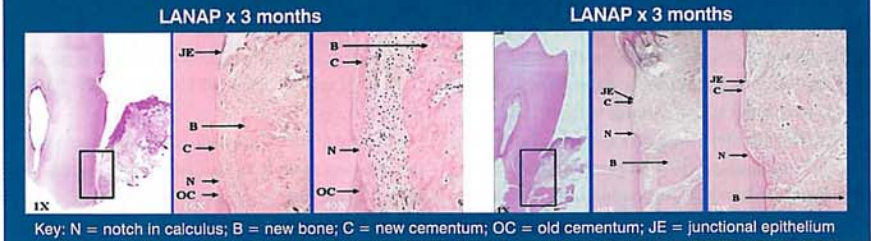
Call Bill Ludwig today at **503-557-0866**.

We can give your office a look that will put a smile on *your* face, too!

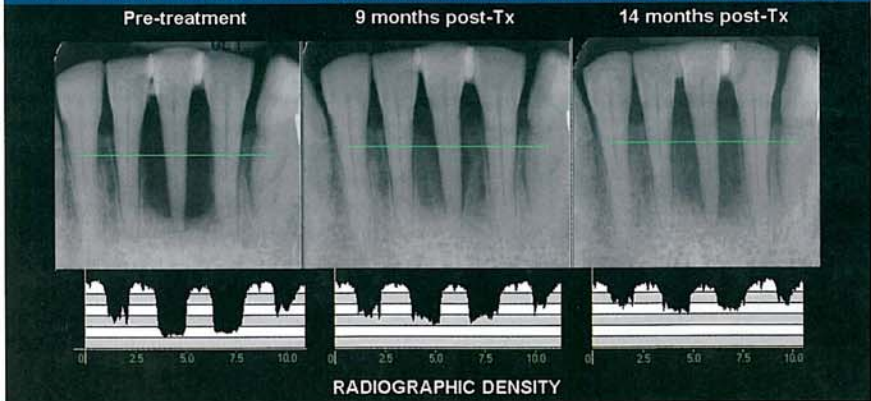
[www.bnkconstruction.com](http://www.bnkconstruction.com)  
OR Lic. #0107555 • WA Lic. BNKCON1055NP

## “Laser Assisted New Attachment Procedure (Laser ANAP)<sup>®</sup> Cementum-mediated periodontal ligament new-attachment to the root surface in the absence of long junctional epithelium.”

(FDA 510k Clearance K030290)



Key: N = notch in calculus; B = new bone; C = new cementum; OC = old cementum; JE = junctional epithelium



# WOW!

Call Now: 1-888-49-LASER (888-495-2737)  
or visit us at: [www.millenniumdental.com](http://www.millenniumdental.com)



Millennium PeriLase<sup>®</sup>, MUP7, Laser Assisted New Attachment Procedure, LANAP, are Trademarks of Millennium Dental Technologies, Inc. All Rights Reserved

**MILLENNIUM**  
DENTAL TECHNOLOGIES, INC.  
Millennium Dental Technologies is a company formed by clinicians, for clinicians.

teria like *Mutans streptococci* and *Lactobacilli* account for about 1 percent of the bacteria, while in a cariogenic biofilm these bacteria dominate the community and make up to 96 percent of the bacteria. At this point, the pH of the biofilm becomes acidic, and the low pH favors additional aciduric bacterial species and drives the loss of calcium and phosphate mineral from the enamel. In the low pH biofilm, the cariogenic bacteria have a high metabolic rate and expend a great deal of ATP to pump H<sup>+</sup> ions out of the cell to maintain intracellular neutrality.<sup>4</sup> To effectively treat dental caries, not only must the teeth be restored to function, but the dental biofilm needs to be restored to a healthy biofilm. The profession has

recognized that inserting fillings, even at a great pace, has little to do with treating or arresting the disease, although it has the temporary effect of relieving pain and restoring function to the teeth.<sup>5</sup>

Caries risk assessment is a philosophy that identifies and addresses the risk factors that are responsible for the biofilm shift from healthy to cariogenic. Local factors, diet, exposure to fluoride, quantity and quality of saliva, in addition to other factors, play a role in the caries process. By thoroughly identifying known risk factors and examining the bacteria in the biofilm, dentists can begin to treat the caries disease and not just the signs and symptoms. As a standard of care, caries risk assessment is

being used by a growing number of clinicians and is taught at all West Coast dental schools including OHSU. All patients being treated at OHSU go through a standardized caries risk assessment and are also assigned a diagnosis of the activity level of the caries process. Not only are the patients screened for low, moderate and high risk for dental caries, but they are also designated as low, moderate and high active. A patient may be high risk for caries and have a highly active disease, figure 1, or may be high risk but low active, figure 2. Treatment decisions are individualized and made based on the caries risk assessment and activity level and address the entire disease process rather than just a one-size-fits-all restoration of cavities.

The probiotic approach to treating dental caries focuses on supporting an oral environment that favors healthy bacteria and a protective biofilm, and discourages the pathogenic bacteria and cariogenic biofilm. Probiotics recognizes that a healthy biofilm is the body's first-line defense mechanism against pathogenic bacteria, in this case the cariogenic, acidogenic, aciduric bacteria.

A new approach to diagnosing and treating dental caries requires new language, procedures, instruments, materials and education. Currently available products include standardized caries risk-assessment forms, bacterial cultures and an assortment of xylitol, fluoride rinses, toothpastes, gums and mints. New products include ATP bioluminescence, rapid culture and oral care products that are antimicrobial in nature. Because the cariogenic bacteria use a tremendous amount of ATP to maintain intracellular neutrality, ATP bioluminescence offers a promising screening test for cariogenic bacteria in the biofilm. By swabbing the tooth surface, figure 3, and measuring the ATP levels present, the cariogenic potential of the biofilm may be estimated. A quick and simple low-cost

Figure 2. High-risk patient with low active caries process.



Figure 3. ATP swab to be used to screen for ATP on a patient's oral biofilm.



# Congratulations

Artisan Dental Laboratory is proud to congratulate our customer of over 35 years, Dr. Nicklis C. Simpson for being recognized in the Doctor of Dentistry Magazine and for all of his personal and professional accomplishments.



## GREAT DENTISTS DESERVE GREAT OFFICES

"Norwest helped me build my dream office. From the beginning, they were very receptive to my vision and everyone was great to work with. Because of the team's experience in dental construction, they had lots of insightful ideas and were particularly attentive to the details, a necessity for dentists. Norwest was also excellent about returning calls and taking care of my requests and last-minute changes. If you want to build your dream office, I would highly recommend them."



David M. Baker, D.M.D.  
Baker Orthodontics  
[ Vancouver, Washington ]

### You too can count on the Norwest team for a great office.

- We specialize in dental office construction.
- From simple to elegant, we work within all budgets.
- We pay attention to the details and complete projects on time.
- With 80+ Portland/Vancouver dental clients, Norwest must be doing something right.



Call Mark Enger now: 503.291.6986, ext. 26  
for your free site evaluation.

Mark's e-mail: [maenger@norwestgc.com](mailto:maenger@norwestgc.com)



NORWEST CONTRACTORS, INC.

screening test allows clinicians to routinely monitor caries risk for their patients. While ATP levels are nonspecific and does not identify specific bacteria in the biofilm, it does show promise as an accurate screening test. Rapid cultures are utilized for a number of determinations, and a rapid culture for *Mutans streptococci* gives the dentist a

Figure 4. Rapid culture of *Mutans streptococci* from patient's biofilm.



valid level of these known pathogens in the patient's biofilm, figure 4. Numerous studies over the past 25 years have established the relationship between these bacterial levels and the incidence, severity and rate of dental caries. By monitoring the bacterial levels, the clinicians can measure the effectiveness of the caries treatment on the biofilm. New antimicrobial oral care products provide short-term therapy against the cariogenic biofilm and long-term maintenance for a healthy biofilm. Unfortunately, most of the currently available oral rinses are low pH, while part of the caries therapy should include raising the pH of the biofilm to favor normal bacteria.

Dental caries is now recognized as a biofilm disease. By treating the entire caries process, the clinician can restore health for the patient and provide better treatment outcomes. ■

#### References:

1. Lappin-Scott HM, Costerton JW. Microbial Biofilms. Cambridge University Press. Cambridge UK. 2003.
2. Marsh PD. Host defenses and microbial homeostasis: role of microbial interactions. J Dent Res 1989; 68:1567-75.
3. Busscher HJ, Evans LV. Oral Biofilms and Plaque Control. Gordon and Breach Publishing 1998.
4. Alice CL Len, Harty DWS, Jaques AJ. Stress-responsive proteins are up regulated in *Streptococcus mutans* during acid tolerance. Microbiol 150 (2004) 1339-1351.
5. Fejerskov O, Kidd E. Dental Caries: The disease and its clinical management. Blackwell Munksgaard 2003 Oxford UK.