along with the AI-2 molecule for quorum sensing to be activated.

AI-2 signaling operates in a diverse sample of bacteria. If the *luxS* gene is inactivated, bacteria cannot produce AI-2, which reduces biofilm production. Some interactions can overrule this situation. Biofilm formation between *Streptococcus gordonii* and *Porphyromonas gingivalis* requires intact *luxS*. *S gordonii* is an early colonizer, but *P gingivalis* is a putative periodontal pathogen. Both species produce AI-2. When *luxS* is inactivated in just one of these species, the biofilm is still formed, but if inactivation of *luxS* occurs in both species, no biofilm is formed. One study has indicated that inactivation of the *luxS* gene and subsequent failure to produce AI-2 leads to an increased sensitivity to chlorhexidine. Antibiotic sensitivity can also be related to AI-2 signaling in bacterial biofilms.

Autoinducer Peptides

The competence stimulating peptide (CSP) pheromone was first found in *S pneumoniae*. It induces competence for the uptake and incorporation of DNA into the host genome. CSP affects the biofilm formation abilities of various oral streptococci. In addition, adaptation to an acidic environment increases with CSP signaling. CSP also induces fratricide, killing, and lysis of noncompetent cells in the oral environment.

CONTROLLING BIOFILMS

Several hundred different bacterial species and strains inhabit the dental biofilm, with the result being a vastly expanded genetic pool of enzymes that can inactivate antibacterial agents, explaining why bacteria in a biofilm are considerably more resistant to these drugs than free bacteria. The extracellular matrix protects the bacteria, but the exact mode of protection remains to be revealed. Possibilities include matrix binding of the antibacterial compounds, which inhibits their penetration and their ability to reach the bacteria. In addition, biofilm bacteria may excrete and concentrate protective enzymes. Biofilm bacteria may also adopt a dormant state that reduces their susceptibility to antibiotics and antibacterial agents. Finally, genetic exchange and transfer of antibacterial-resistant genes may occur more readily in a biofilm environment.

Despite these challenges, novel compounds, technologies, and methods are being researched in an effort to eradicate or prevent the formation of oral biofilms. Agents may ultimately be added to toothpastes and oral rinses or incorporated into dental restorative materials. Reduced bacterial adhesion may be addressed by engineering the material and tooth surfaces of restored structures. Already available are products that work through photodynamic therapy to kill bacteria in biofilms. Probiotic bacteria have also been used to maintain biofilm ecology in a healthy state or restore it to this state. Efforts to interfere with bacterial communication do not kill bacteria but should make them less virulent.

DISCUSSION

Diseases related to the oral biofilm, including caries and periodontitis, develop when dysbiosis of the oral microbiome occurs. Because biofilm bacteria are significantly less sensitive to the antibacterial agents commonly used, research into new products and new methods is essential.

Clinical Significance

In pursuing new approaches to addressing the problems with a disbiotic dental biofilm, it's essential to understand the complex properties and interplay among biofilm bacteria. In addition, until those new agents and methods are available and even beyond that time, patients should be educated to perform daily mechanical biofilm disruption (tooth brushing) and to make lifestyle changes that support a healthy oral environment.

Valen H, Scheie AA: Biofilms and their properties. *Eur J Oral Sci* 126:13-18, 2018

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ORAL HYGIENE

Dry brushing

BACKGROUND

The removal of plaque through routine oral hygiene is a well-accepted method of protecting teeth from becoming infected by bacteria, carious, and eventually lost from the dentition. Because caries remains an important public health concern, it's clear that our tooth brushing practices could be improved. One method that has been proposed is brushing with a dry toothbrush rather than a prewetted one. The claim has been made that dry brushing will remove more dental plaque and will increase the subject's perception of smoothness of tooth surfaces,

indicating a clean tooth. A comparison of the dry and prewetted toothbrush methods was done using participants from 2 previous experiments involving single-brushing exercises.

METHODS

The 46 participants were systemically healthy and at least age 18 years (range 20 to 34 years). All were required to refrain from oral hygiene for 48 hours before beginning the experiments. The control intervention was brushing with a prewetted toothbrush, and the test intervention was brushing with a dry toothbrush. No dentifrice was used. Plaque status was scored before and after brushing each time. In addition, subjects completed a questionnaire to judge their perceptions of the process.

RESULTS

The mean plaque scores obtained before brushing did not differ significantly, nor did those obtained after brushing. Plaque score reduction was 58% with the dry toothbrush and 57% with the prewetted toothbrush. The difference between the 2 methods was not statistically significant.

Subjects reported having to refrain from oral hygiene for 48 hours before each experiment as uncomfortable, as was brushing without a dentifrice. The latter applied to both dry and prewetted tooth brushing. Toothbrush filament stiffness was perceived as between soft and rigid whether wet or dry. The subjects' perceptions of cleaning capability were not significantly different between the 2 brushing methods.

DISCUSSION

The overall reduction in dental plaque scores was at least 57% after a 2-minute brushing exercise for both the dry and the prewetted tooth brushing. Thus dry brushing was no more effective than prewetted brushing in removing plaque, and prewetting was not superior in plaque removal ability to dry brushing.

Clinical Significance

Dentists should encourage their patients to brush their teeth daily even if they do it with a dry brush. It will be just as effective as brushing with a prewetted brush. Use of a dentifrice is likely to be preferred by patients, but it's not essential for obtaining clean teeth.

van der Sluijs E, Slot DE, Hennequin-Hoenderdos NL, et al: Dry brushing: Does it improve plaque removal? A secondary analysis. *Int J Dent Hygiene* 16:519-526, 2018

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ORAL/SYSTEMIC CONNECTIONS

Mouthwash and increased risk for diabetes

BACKGROUND

A 2017 study stated that people who use over-the-counter mouthwash at least twice a day have about a 50% increased risk for developing prediabetes/diabetes over a 3-year period compared to people who use mouthwash less often or not at all. This outcome was evaluated by looking at the study itself, the proposed mechanism by which this outcome might occur, the role of oral bacteria in health, and methodological limitations found in the study.

SAN JUAN OVERWEIGHT ADULTS LONGITUDINAL STUDY SUMMARY

Overweight and obese adults age 40 to 65 years were recruited. Blood samples were taken from the 945 participants, who were then divided into those who were normoglycemic, those who had prediabetes, and those who had diabetes. A complete periodontal evaluation was done to assess periodontal status. Data on oral hygiene practices, including the use of mouthwash, were collected via questionnaire. The key finding was that individuals who used mouthwash twice a day or more at baseline, which was 22% of participants, had a significantly increased risk of developing prediabetes/diabetes over the next 3 years compared to those who used mouthwash less than twice daily. The effect remained as an approximately 50% increased risk of developing prediabetes/diabetes even after considering income, education, oral hygiene, oral conditions, sleep breathing disorders, diet, medications, insulin resistance, fasting glucose level, 2-hour post-load glucose level, or C-reactive protein. The effect was not related to mouthwash use once a day.

PROPOSED MECHANISM

Nitric oxide (NO) is important in many cellular functions throughout the body, especially in vascular function and blood flow. Defective NO production is associated with endothelial