ORIGINAL ARTICLE

Bacterial colonization of a power-driven water flosser during regular use. A proof-of-principle study

Kristina Bertl1,2 | Pia Edlund Johansson1 | Corinna Bruckmann3 | Matthias Leonhard4 | Julia R. Davies5 | Andreas Stavropoulos1,3,6

1Faculty of Odontology, Department of Periodontology, University of Malmö, Malmö, Sweden
2Division of Oral Surgery, University Clinic of Dentistry, Medical University of Vienna, Vienna, Austria
3Division of Conservative Dentistry and Periodontology, University Clinic of Dentistry, Medical University of Vienna, Vienna, Austria
4Division of Phoniatrics-Logopedics, Department of Otorhinolaryngology, Medical University of Vienna, Vienna, Austria
5Faculty of Odontology, Department of Oral Biology, University of Malmö, Malmö, Sweden
6Division of Regenerative Dentistry and Periodontology, University Clinics of Dental Medicine (CUMD), University of Geneva, Geneva, Switzerland

Correspondence
Andreas Stavropoulos, Division of Regenerative Dentistry and Periodontology, University Clinics of Dental Medicine (CUMD), University of Geneva, Rue Michel-Servet 1, Geneva 1211, Switzerland.
Email: andreas.stavropoulos@unige.ch

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Abstract
Objectives: The present proof-of-principle study assessed whether daily use of a power-driven water flosser (Sonicare AirFloss; SAF) leads to bacterial colonization in the nozzle and/or the device, resulting in contaminated water-jet.

Material and Methods: In five participants, saliva samples at baseline and water-jet samples of devices used daily with bottled water for 3 weeks (test) were collected. Additionally, water-jet samples from devices used daily with bottled water extraorally for 3 weeks (positive control) and from brand new devices (negative control), as well as samples from newly opened and 1- and 3-week opened water bottles were collected. Colony forming units (CFU) were recorded after 48 h culturing and 20 oral pathogens were assessed by polymerase chain reaction-based analysis.

Results: Distinct inter-individual differences regarding the number of detected bacteria were observed; water-jet samples of test devices included both aerobic and anaerobic bacterial species, with some similarities to the saliva sample of the user. Water-jet samples from positive control devices showed limited number of aerobic and anaerobic bacterial species, while the samples from negative control devices did not show any bacterial species. Very few aerobic bacteria were detected only in the 3-week-old bottled water samples, while samples of newly and 1-week opened water bottles did not show any bacterial growth.

Conclusions: The present proof-of-principle study showed that daily use of a power-driven water flosser for 3 weeks resulted in bacterial colonization in the nozzle and/or device with both aerobic and anaerobic, not only oral, species, that are transmitted via the water-jet.

KEYWORDS
AirFloss, biofilm, contamination, interdental cleaning device

1 | INTRODUCTION

Mechanical cleaning of the teeth is essential to minimize the risk of caries and periodontal disease. In addition to the daily use of a manual or electric toothbrush, an interdental cleaning aid should also be used (Chapple et al., 2015; Christou et al., 1998; Noorlin & Watts, 2007; Sälzer et al., 2015; Slot et al., 2008). Several manual (e.g., dental floss, interdental brushes, wooden toothpicks) and a few power-driven devices (e.g., oral irrigators) are currently available; but based on available evidence no aid can be clearly suggested as superior in terms...
of effectiveness for plaque removal and/or disease prevention (Slot et al., 2008; Worthington et al., 2019).

Patient acceptability of the method and the degree of patient compliance are important aspects with regards to the effectiveness of the method/device; for example, power-driven devices seem to be preferred by most patients (Heiß-Kisielewsky et al., 2015; Shibly et al., 2001). One such power-driven device for interdental cleaning is the Sonicare AirFloss (Royal Philips N.V., Amsterdam, the Netherlands; SAF), which emits a microburst of high velocity air and liquid micro-droplets causing a shear stress on the interproximal tooth surface to detach any biofilm accumulation (Rmaile et al., 2014, 2015). Although the clinical efficacy of the SAF is still unclear (Heiß-Kisielewsky et al., 2015; Mwatha et al., 2017; Stauff et al., 2018), it seems that it indeed achieves higher acceptance among patients compared to flossing (Heiß-Kisielewsky et al., 2015).

In this context, a possible drawback of such a device is the risk of bacterial colonization and biofilm formation. Since the tip of the nozzle of SAF comes in contact with the oral environment, bacterial colonization of the tip is likely, similarly to toothbrushes (Ankola et al., 2009; Balapannavar et al., 2009; Frazelle & Munro, 2012; Mehta et al., 2007); such colonization might initiate and/or contribute to biofilm formation in the nozzle and/or in the device itself. Furthermore, all water pipework systems are at risk of biofilm build-up (Gagnon et al., 2001). One such power-driven device for interdental cleaning device or mouth-rinse, and also not to receive professional oral hygiene and/or any form of periodontal treatment. After 3 weeks of regular use the participants had to stop using the device for 24 h and then return it to the clinic for water-jet sampling.

2.2 | Extra-oral use of SAF (positive and negative control)

Two brand new devices were used as above for 3 weeks, but extra-orally (positive controls); that is, bottled water was used (one bottle/week) to fill the container and the device was repeatedly activated until the container was emptied. As above, the device was hygienically used; that is, the nozzle was rinsed only with the bottled water, the container was emptied and swabbed with a clean paper tissue after each use, the nozzle was not touched with the fingers, and the nozzle was not exchanged. Again, the devices were not used 24 h prior to water-jet sampling. In addition, water-jet samples from two additional brand-new devices, filled with bottled water as above, were collected (negative controls).

2.3 | Saliva, water-jet, and bottled water sampling

At baseline, a stimulated saliva sample was collected from each participant by using a saliva collection system (Greiner Bio One, Kremsmunster, Austria) according to the manufacturer’s instructions. Specifically, patients were instructed to rinse the oral cavity with the saliva extraction solution (4 ml, citrate buffer pH 4.2) for 2 min; then stimulated whole saliva mixed with the extraction solution was collected in a beaker. For water-jet sampling, the SAF container was filled with water from a new bottle and 2.5 ml water-jet samples were collected with the used (test and positive control devices) or a brand-new nozzle (negative control devices) into a sterile tube. Samples from a newly, and 1- and 3-week opened water bottle were also collected. Immediately after collection and removal of the amount required for culturing, both saliva samples and water-jet samples were stored at −80°C until polymerase chain reaction (PCR)-based analysis.

2.4 | Culturing of aerobic and anaerobic bacteria

The water-jet samples of the test devices were transferred to brain heart infusion agar plates with blood supplementation and
were grown/maintained in 5% CO₂ in air at 37°C (20 μl water-jet sample/plate) and anaerobic (100 μl water-jet sample/plate; 85% nitrogen, 10% hydrogen, 5% CO₂) conditions. The water-jet samples of positive and negative control devices, as well as water samples from the newly, and 1- and 3-week opened water bottles were analyzed in a similar fashion, using 200 μl of the water-jet samples/plate for both conditions. After 48 h, the total number of colony forming units (CFU) per plate was counted and expressed as log₁₀ CFU per milliliter sample.

2.7 | Statistical analysis

Data derived from culturing and PCR-based analysis were summarized and reported descriptively.

3 | RESULTS

All participants returned the SAF after 3 weeks and reported regular daily use of the device as instructed. No discomfort or any other remarkable observation related to SAF use was reported.

3.1 | Intraoral use of SAF (test) and saliva samples

All water-jet samples, after 3 weeks of daily intra-oral use of SAF, presented aerobic and anaerobic bacterial contamination, typical for water pipes; however, inter-individual differences in the number and type of colonies were present (Table 1 and Figure 1). The total number of log₁₀ CFU per milliliter sample ranged for aerobic bacteria from 3.45 to 4.96 (mean 4.33, SD 0.62) and for anaerobic bacteria from 2.30 to 4.83 (mean 3.82, SD 0.94), respectively. Similar inter-individual differences were present in the PCR-based analysis. While in the water-jet sample of one participant none of the tested oral pathogens was detected, two participants showed minor contamination with V. parvula and S. gordonii, and another two participants showed positive test results for eight oral pathogens (A. viscosus, F. nucleatum, A. odontolyticus, Capnocytophaga sp., S. constellatus, S. mitis, S. gordonii, and V. parvula).

The results of the PCR-based analysis of the saliva samples is presented in Table 2; 16–19 out of 20 tested pathogens had been tested positive in each sample. Due to the limited number of participants, no correlation between the number and/or type of bacteria detected in the saliva sample and the corresponding water-jet sample was attempted. Nevertheless, all cases with a positive water-jet result for one of the oral pathogens also presented a relatively higher number of the specific bacterium in the saliva sample (i.e., the semiquantitative analysis indicated ++ or +++), except for a single case bacterium (i.e., Participant #2, A. viscosus; Table 2).

| Intraoral use of SAF (test) and saliva samples |
|-----------------------------------------------|
| Water samples |
| Bottled water | 0 | 0 |
| Bottled water after 1 week | 0 | 0 |
| Bottled water after 3 weeks | 1.88 | 0 |

Abbreviations: CFU, colony forming unit; SAF, Sonicare AirFloss.
3.2 | Extra-oral use of SAF (positive and negative control) and bottled water samples

After 3 weeks of daily extra-oral use of SAF (positive control), all water-jet samples presented aerobic and anaerobic bacterial contamination, however, the number was distinctively lower compared to water-jet samples from the test SAF devices (Table 1). No bacterial growth was observed in water-jet samples from negative control devices. Similarly, no bacterial growth was observed in samples from a newly opened and 1-week-old water bottle. Very few aerobic bacteria were detected in samples from the 3-week-old bottled water. None of the water jet-samples of the positive and negative controls, nor any of the water samples showed any positive results in the PCR-based analysis of oral pathogens.

3.3 | Biofilm formation at the tip of the nozzle

SEM analysis of the tip of the nozzle of the device used by one of the participants (#2) presented a thin biofilm on the outside of the tip of the nozzle (i.e., at the aspect positioned into the interproximal space; Figure 2c,d), but no biofilm formation at the inside of the tip (Figure 2e). The bacterial deposit comprised of a variety of bacteria embedded in a very dense extracellular matrix sticking to the surface of the tip of the nozzle (Figure 2d).

4 | DISCUSSION

The results of the present proof-of-principle study clearly showed that SAF devices are colonized by bacteria, not only oral species, even after a short period of regular use, and that these can be transmitted via the water-jet. Specifically, both aerobic and anaerobic colonies were found in all water-jet samples collected from all devices used intra-orally (tests) and those used extra-orally for 3 weeks (positive controls), while oral bacteria were found in the water-jets of four out of five test devices.

Colonization with oral bacteria may come as no surprise, since the tip of the nozzle of the SAF comes in contact with the oral
TABLE 2 Results of the PCR-based analysis of 20 oral pathogens

|                          | Intra-oral use for 3 weeks (test) |
|--------------------------|-----------------------------------|
|                          | #1 Saliva SAF #2 Saliva SAF #3 Saliva SAF #4 Saliva SAF #5 Saliva SAF |
| **A. actinomycetemcomitans** | ++ – + – ++ – – – ++ – – |
| **A. viscosus** | ++ ++ + ++ ++ – – ++ – |
| **T. forsythia** | (+) – (+) – + – ++ – +++ – |
| **C. rectus/showae** | + – (+) – (+) – + – ++ – |
| **T. denticola** | ++ – + – ++ – ++ – +++ – |
| **E. corrodens** | + – +++ – (+) – ++ – +++ – |
| **P. intermedia** | ++ – ++ – ++ – ++ – +++ – |
| **P. micra** | ++ – – – ++ – +++ – +++ – |
| **P. gingivalis** | – – – – – – – – +++ – |
| **F. nucleatum** | +++ + +++ ++ +++ – +++ – +++ – |
| **A. odontolyticus** | +++ + +++ ++ +++ – +++ – +++ – |
| **Capnocytophaga sp.** | ++ ++ ++ +++ ++ – ++ – +++ – |
| **C. concisus** | +++ – ++ – ++ – ++ – – |
| **E. nodatum** | – – – – – – – – – + |
| **S. constellatus group** | +++ + ++ (+) ++ – +++ – +++ – |
| **C. gracilis** | ++ – – – – – – ++ – + |
| **S. mitis group** | +++ (+) +++ ++ +++ – +++ – +++ – |
| **P. nigrescens** | ++ – (+) – – – – ++ – + |
| **S. gordonii group** | +++ + ++ (+) +++ – +++ – +++ + |
| **V. parvula** | +++ ++ +++ +++ – +++ + +++ ++ |

Abbreviation: SAF, Sonicare AirFloss.

FIGURE 2 The tip of the nozzle of Participant #2 was examined by scanning electron microscopy. On the outside of the tip of the nozzle (a, b) a thin biofilm (c, d) was detected, but on the inside of the tip (e) biofilm formation was absent. The blue arrow (a, b, e) always indicates the same spot.
environment and colonization with oral bacteria has been previously reported for other intraoral cleaning devices such as toothbrushes (Ankola et al., 2009; Balappanavar et al., 2009; Frazier & Munro, 2012; Mehta et al., 2007). Interestingly, positive control devices (i.e., devices used extra-orally for 3 weeks) also showed contaminated water-jet samples, but to a lower degree compared to the test devices and no colonization was seen with the tested oral bacteria. This finding, together with the fact that the water-jet of negative control devices (i.e., brand-new devices) as well as bottled water samples showed basically no contamination, indicates colonization of SAF also from extra-oral sources, such as the skin, the cheek or fingers, or simply the direct surroundings, despite that the devices were used hygienically to prevent any contamination. Furthermore, the negative PCR results for all tested oral pathogens in Participant #3, despite the relatively high CFU count for aerobic and anaerobic bacteria, does not exclude the possibility of contamination from oral bacteria in this specific case; it is important to remember, that cariogenic bacteria, such as Streptococcus mutans, were not assessed in this study.

Since in SAF water is passed from the container of the device to the nozzle and tip, through a circuit of channels/pipes inside the device, it appears logical that biofilm formation in the nozzle and/or the pipework occurs also in SAF, similarly to every aqueous pipework (Gagnon et al., 2005; Wang et al., 2012). Nevertheless, it is noteworthy that this colonization of the nozzle and/or device results in a contaminated water-jet delivered into the oral cavity. Thus, depending on the localization of the biofilm, that is, in the nozzle and/or in the device itself, the potential risk of cross-contamination among family members/partners should be considered. Currently, it is recommended that one device may be used by more than one person and only the nozzle should be exchanged (i.e., each family member/partner should have its own nozzle). If the localization of the biofilm is not only in the nozzle, but also in the device itself, it is apparent that exchanging the nozzle may not be an adequate protection measure against cross-contamination by oral and/or other pathogens. In perspective, colonization of the oral cavity through cross-contamination, for example, from the mother to the child or between partners has been shown/suggested for cariogenic and periodontal pathogens (Berkowitz, 2006; Kort et al., 2014; Okada et al., 2004; Tamura et al., 2006). Nevertheless, it is uncertain, whether a daily limited/single exposure to a certain number of exogenous bacteria—as the one expected through the water-jet of SAF—is actually sufficient to lead to a permanent change/manipulation of the oral microbiome of the exposed person. For example, it has been shown that even intimate kissing, which is assumed to cause an average transfer of 80 million bacteria within 10 s kiss duration, requires a relatively high daily frequency to result in some degree of shared salivary microbiota (Kort et al., 2014). However, the SAF should be also considered as a potential source for re-infection during periodontal treatment. Thus, if the device was already used before initiating periodontal treatment, continuous use of the same nozzle and/or device—depending on the localization of the biofilm—may to a certain degree contribute to re-infection of the treated periodontal pockets. In a similar fashion, several microbial niches in the oral cavity other than the pockets (e.g., tongue, tonsils) have been discussed as potential sources for re-infection (Quirynen et al., 1995; Teughels et al., 2009).

The localization of this colonization (i.e., only in the nozzle or also in the device itself) was not within the scope of this proof-of-principle investigation; as sampling was performed only with a used nozzle, no assumptions can be made regarding the localization of this colonization. Lack of biofilm formation at the inside of the upper part of the nozzle (Figure 2), observed by SEM analysis in a single case in this study, may indeed indicate that colonization was only localized in the upper part of the nozzle and that the entire amount of the biofilm was transmitted (removed) with the water-jet, that is, the nozzle gets cleaned through by the shear stress of the microburst of high velocity air and liquid micro-droplets generated by the device, analogous to what is in theory happening at the teeth. However, as neither the entire nozzle nor the device itself was examined, bacterial colonization deeper inside the nozzle or within the device cannot be excluded. The fact that cases with a positive water-jet result for a given oral pathogen, also presented relatively higher numbers of the specific bacterium in the saliva sample, may indicate some correlation between the health status (e.g., healthy person vs. periodontitis patient) and the relative risk for colonization of the SAF with periodontal pathogens; however, due to the limited number of participants herein, no final assumptions on this should be made.

Future studies should assess the localization of the biofilm, and the effect of specific cleaning procedures to reduce or prevent biofilm build-up, as the currently recommended approach to empty and carefully swab the container with a clean paper tissue after each use is inefficient. For example, specific cleaning procedures (e.g., simple immersion in 0.12% chlorhexidine gluconate or 1% sodium hypochlorite for 20 h) have been described to reduce successfully the bacterial load on toothbrushes (Balappanavar et al., 2009; do Nascimento et al., 2014; Mehta et al., 2007; Nelson-Filho et al., 2000, 2006). Furthermore, the possible impact of using SAF with a mouth-rinse instead of water on the bacterial colonization of the nozzle and/or the device should be assessed, as the manufacturer in fact recommends using the SAF with tap water or with a mouth-rinse. Finally, it has to be stressed that the findings of the present proof-of-principle study are not restricted to this specific water flosser, but most likely apply to all oral irrigators—since all come in contact with the oral environment and have a pipework system.

In conclusion, the present study showed that daily use of SAF for 3 weeks resulted in bacterial colonization in the nozzle and/or device with both aerobic and anaerobic, not only oral, species, that are transmitted via the water-jet.

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CONFLICT OF INTEREST
All authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
Kristina Bertl, Pia Edlund Johansson, and Andreas Stavropoulos: made substantial contribution in conception and design of the work, in the acquisition and analysis of data, and made substantial contribution in drafting and/or revising the work critically for important intellectual content. Corinna Bruckmann, Matthias Leonhardt, and Julia R. Davies: have made substantial contribution in the acquisition and analysis of data for the work and in drafting the work. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID
Kristina Bertl https://orcid.org/0000-0002-8279-7943
Andreas Stavropoulos https://orcid.org/0000-0001-8161-3754

REFERENCES
Ankola, A. V., Hebbal, M., & Eshwar, S. (2009). How clean is the toothbrush that cleans your tooth? International Journal of Dental Hygiene, 7, 237–240. https://doi.org/10.1111/j.1601-5037.2009.00384.x
Balapanavar, A. Y., Nagesh, L., Ankola, A. V., Tangade, P. S., Kakodkar, P., & Varun, S. (2009). Antimicrobial efficacy of various disinfecting solutions in reducing the contamination of the toothbrush--A comparative study. Oral Health & Preventive Dentistry, 7, 137–145.
Berkowitz, R. J. (2006). Mutans streptococci: acquisition and transmission. Pediatric Dentistry, 28, 106–109.
Chapple, I. L., Van der Weijden, F., Doerfer, C., et al. (2015). Primary prevention of periodontitis: Managing gingivitis. Journal of Clinical Periodontology, 42(16), S71–S76. https://doi.org/10.1111/j.12366
Christou, V., Timmerman, M. F., Van der Velden, U., & Van der Weijden, F. A. (1998). Comparison of different approaches of interdental oral hygiene: Interdental brushes versus dental floss. Journal of Periodontology, 69, 759–764. https://doi.org/10.1902/jop.1998.69.7759
Do Nascimento, C., Sorgini, M. B., Pita, M. S., et al. (2014). Effectiveness of three antimicrobial mouthrinses on the disinfection of toothbrushes stored in closed containers: A randomized clinical investigation by DNA checkerboard and culture. Gerodontology, 31, 227–236. https://doi.org/10.1111/ger.12035
Frazelle, M. R., & Munro, C. L. (2012). Toothbrush contamination: A review of the literature. Nursing Research & Practice, 2012, 420630. https://doi.org/10.1155/2012/420630
Gagnon, G. A., Rand, J. L., O’leary, K. C., Rygel, A. C., Chauret, C., & Andrews, R. C. (2005). Disinfectant efficacy of chlorite and chlorine dioxide in drinking water biofilms. Water Research, 39, 1809–1817. https://doi.org/10.1016/j.watres.2005.02.004
Heiß-Kisielewsky, I., Sandbichler, L., & Kapferer-Seebacher, I. (2015). Plaque reduction with the Sonicare AirFloss compared with flossing: A randomized controlled crossover study. Parodontologie, 26, 41–49.
Kort, R., Caspers, M., van de Graaf, A., van Egmond, W., Keijser, B., & Roeselers, G. (2014). Shaping the oral microbiota through intimate kissing. Microbiome, 2, 41. https://doi.org/10.1186/2049-2618-2-41
Mehta, A., Sequeira, P. S., & Bhat, G. (2007). Bacterial contamination and decontamination of toothbrushes after use. The New York State Dental Journal, 73, 20–22.
Mwatha, A., Olson, M., Souza, S., Ward, M., Jenkins, W., Amini, P., Gallob, J., & Fafard, T. (2017). Gingival health and plaque regrowth response following a four-week interdental hygiene intervention. The Journal of Clinical Dentistry, 28, A36–A44.
Nelson-Filho, P., Macari, S., Faria, G., Assed, S., & Itò, I. Y. (2000). Microbial contamination of toothbrushes and their decontamination. Pediatric Dentistry, 22, 381–384.
Nelson-Filho, P., Faria, G., da Silva, R. A., Rossi, M. A., & Itò, I. Y. (2006). Evaluation of the contamination and disinfection methods of toothbrushes used by 24- to 48-month-old children. Journal of Dentistry for Children (Chicago, Ill.), 73, 152–158.
Noorlin, I., & Watts, T. L. (2007). A comparison of the efficacy and ease of use of dental floss and interproximal brushes in a randomised split mouth trial incorporating an assessment of subgingival plaque. Oral Health & Preventive Dentistry, 5, 13–18.
Okada, M., Hayashi, F., Soda, Y., Zhong, X., Miura, K., & Kozai, K. (2004). Intra-familial distribution of nine putative periodontopathogens in dental plaque samples analyzed by PCR. Journal of Oral Science, 46, 149–156.
Quirynen, M., Bollen, C. M., Vandekeerkhove, B. N., Dekeyser, C., Papaioannou, W. N., & Eysen, H. (1995). Full- vs. partial-mouth disinfection in the treatment of periodontal infections: Short-term clinical and microbiological observations. Journal of Dental Research, 74, 1459–1467. https://doi.org/10.1177/00220345950740080501
Rmaile, A., Carugo, D., Capretto, L., Aspiras, M., De Jager, M., Ward, M., & Stoodley, P. (2014). Removal of interproximal dental biofilms by high-velocity water microdrops. Journal of Dental Research, 93, 68–73.
Rmaile, A., Carugo, D., Capretto, L., Wharton, J. A., Thurner, P. J., Aspiras, M., Ward, M., De Jager, M., & Stoodley, P. (2015). An experimental and computational study of the hydrodynamics of high-velocity water microdrops for interproximal tooth cleaning. Journal of the Mechanical Behavior of Biomedical Materials, 46, 148–157. https://doi.org/10.1016/j.jmbbm.2015.02.010
Sääler, S., Slot, D. E., Van der Weijden, F. A., & Dörfer, C. E. (2015). Efficacy of inter-dental plaque control in managing gingivitis—A meta-review. Journal of Clinical Periodontology, 42(16), S92–S105. https://doi.org/10.1111/j.12363
Shibly, O., Ciancio, S. G., Shostad, S., Mather, M., & Boardman, T. J. (2001). Clinical evaluation of an automatic flossing device vs. manual flossing. The Journal of Clinical Dentistry, 12, 63–66.
Slot, D. E., Dörfer, C. E., & Van der Weijden, G. A. (2008). The efficacy of interdental brushes on plaque and parameters of periodontal inflammation: A systematic review. International Journal of Dental Hygiene, 6, 253–264. https://doi.org/10.1111/j.1601-5037.2008.00330.x
Stauff, I., Deman, S., Barbe, A. G., Hoefer, K. C., Bishang, M., Zimmer, S., & Noack, M. J. (2018). Efficacy and acceptance of a high-velocity microdroplet device for interdental cleaning in gingivitis patients—A monitored, randomized controlled trial. International Journal of Dental Hygiene, 16, e31–e37. https://doi.org/10.1111/idh.12292
Tamura, K., Nakano, K., Hayashibara, T., Nomura, R., Fujita, K., Shintani, S., & Ooshima, T. (2006). Distribution of 10 periodontal bacteria in saliva samples from Japanese children and their mothers. Archives of Oral Biology, 51, 371–377. https://doi.org/10.1016/j.archoralbio.2005.09.008
Teughels, W., Dekeyser, C., Van Essche, M., & Quirynen, M. (2009). One-stage, full-mouth disinfection: Fiction or reality. Periodontology 2000, 50, 39–51. https://doi.org/10.1111/j.1600-0757.2008.00292.x
Wang, H., Hu, C., Hu, X., Yang, M., & Qu, J. (2012). Effects of disinfectant and biofilm on the corrosion of cast iron pipes in a reclaimed water distribution system. *Water Research, 46*, 1070-1078. https://doi.org/10.1016/j.watres.2011.12.001

Worthington, H. V., MacDonald, L., Poklepovic Pericic, T., et al. (2019). Home use of interdental cleaning devices, in addition to toothbrushing, for preventing and controlling periodontal diseases and dental caries. *Cochrane Database of Systematic Reviews, 4*, CD012018. https://doi.org/10.1002/14651858.CD012018.pub2

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