

A novel method shaping the future of oral hygiene

The two leading causes of poor oral health – caries and periodontal disease – affect more than 3.5 billion people. Oral prophylaxis helps to reduce the risk of gum and tooth disease. Minimally invasive and pain-free, Guided Biofilm Therapy (GBT) is a systematic, predictable, and scientifically proven treatment for professional prophylaxis. GBT involves the combination of warm water, air, and fine powder to completely remove oral biofilm. However, variations in powder consumption of air-polishing devices suggest that they do not all perform to the same standard. Dr Marcel Donnet, Dr Maxime Fournier, Professor Patrick Schmidlin, and Professor Dr Adrian Lussi from Switzerland, address this issue with a novel method to assess air-polisher device performance. Based on light dispersion, their method provides accurate measurements of powder delivery, determining the most effective and least invasive air-polisher devices for oral prophylaxis.

Oral health is important for general health and wellbeing. Tooth decay occurs when bacteria break down sugar in the mouth, producing acid and removing minerals from the outer layers of the teeth. Accumulation of plaque – also called biofilm – causes various dental diseases including gingivitis (bleeding of the gums), periodontitis (severe gum infection), and tooth decay (caries). Oral preventative measures, known as oral prophylaxis, are dental procedures performed primarily to help reduce the risk of gum and tooth disease.

MODERN ORAL PROPHYLAXIS

The modern oral prophylaxis method, Guided Biofilm Therapy (GBT), is the most effective and minimally abrasive procedure for removing oral biofilm. Developed in 2015, GBT has revolutionised the treatment of dental diseases and professional teeth cleaning. In an eight-step protocol, GBT applies

the use of dental powder via air-flow devices. This paradigm change, through more intensive use of powder jet technology, allows teeth to be cleaned in a comfortable, gentle, time efficient, and effective manner.

There are many air-polishing devices on the market but it is important to know whether they can fulfil GBT's minimally invasive approach. Factors including powder choice and powder delivery to the tooth surface are important when considering the right device for treatment. Knowing the quantity of powder delivered to the tooth is not only important for efficient cleaning but also for minimising tooth abrasion and over-treatment. However, there is a lack of insight into exact powder delivery behaviour of different air-polishing devices. A collaborative team of scientists and researchers from Switzerland including Dr Marcel Donnet, Dr Maxime Fournier, Professor Patrick Schmidlin, and Professor



Oral prophylaxis is primarily performed to help reduce the risk of gum and tooth disease.



Oral medicine and prevention are the future of dentistry.

Dr Adrian Lussi, set out to design a method to help understand differences in the behaviour of air-polishing devices, thus helping to make the right choice to perform GBT.

MEASURING POWDER CONSUMPTION

The team based its method on light dispersion, which occurs as a powder passes through a beam of laser light. Importantly, the team established the relationship between light intensity and the quantity of powder (ie, powder consumption). A spectrometer records dispersed light when moving particles are illuminated by a laser source. Exact

handy devices (smaller entry-level devices mostly for the dentist, allowing quick treatment). The devices were evaluated in low pressure and gentle powder mode, representative of an advanced minimally invasive procedure. Powder consumption tests were performed ten times randomly over a three-week period for statistical analysis.

Overall, the table-top devices had more regular flow rates and longer autonomies than the handy devices due to their larger powder chambers. The AIRFLOW® Prophylaxis Master (table-top E1 device) had the longest

burst at the beginning of each pedal press interval. This was caused by residual powder inside the device tubing. For example, the table-top M3 (Combi Touch) had a high powder burst (> 8g/min) compared to the AIRFLOW® Prophylaxis Master (> 2g/min). This intense burst is clinically important as it can cause an over-delivery of dental powder and subsequent overlay of residue on the tooth surface. In turn, this may result in inefficient cleaning, reducing the clinical effectiveness of treatment. It can also lead to high powder consumption and powder wastage, increasing treatment costs.

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measurements are obtained from the total amount of powder passing through the system, recorded by weighing the powder chamber of the device before and after the test.

AIR-POLISHING DEVICE VARIABILITY

Using the new method, six air-polishing devices were compared: three table-top devices (these are larger professional devices for the hygienist) and three

autonomy with the most regular powder consumption, offering a slow decrease slope of powder release. The handy E1 device (Handy 3.0 Perio) had the longest autonomy compared to other handy devices. Notably, the researchers found that the working behaviour inside the powder chamber caused the most variation between devices.

All devices demonstrated significant variability in the intensity of powder

Device variability is also a result of the powder behaviour within the powder chamber from its start-up time to the stabilisation phase (0.5–5 seconds). An ideal device achieves constant powder consumption during one pedal press. This powder consumption stabilisation was achieved faster in handy devices compared to table-top devices. After five seconds all devices reached a steady state, but only in handy E1, and table-top E1 and M3 did this result in a regular mean powder consumption.

Other devices showed a decrease in mean powder consumption over time with many peaks of high powder consumption. In other words, most devices will show an over-consumption



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at the beginning of each pedal press. Only table-top E1 and M3 do not have this behaviour.

Different mechanisms employed by the devices to expel powder also affect powder consumption. The AIRFLOW® Prophy Master is the only device that uses a 'venturi' powder principle, whereby powder is taken from the bottom of the chamber. This device showed controlled behaviour

powder delivery was measured over time due to decreased volume in the powder chamber. Furthermore, the mean quantity of powder delivered was not well-controlled.

This was seen in the table-top M3, which had extremely high powder consumption. As a result, this device over-consumes powder and generates more dust as the user cannot compensate for the faster powder delivery by speeding up, making

The optimisation of air-polisher powder consumption is key to providing best oral prophylaxis.

with a steady powder consumption, ensuring high reproducibility between patients. This device also had the least instantaneous powder consumption, making it easy to use since its performance is predictable. This is purely due to the working mechanism as the decrease in powder volume does not affect the resulting powder consumption.

In contrast, the other devices use a 'swirling' pick-up method, whereby powder is taken from the top of the powder chamber. This method was found to be much less predictable and repeatable, since a decrease in

cleaning harder with a high-speed suction device. This is clinically important as the performance of the table-top M3 would likely decline quickly and require regular refills.

Interestingly, the Varios Combi Pro (table-top N2) working mechanism shows that as the powder volume decreases in the powder chamber, the powder consumption consequently decreases. This could result in a change in device functionality for two different mouths and the user potentially experiencing a change in cleaning capacity as the chamber empties.

CLINICAL IMPORTANCE

A large variation in powder consumption has detrimental effects on oral prophylaxis treatment. An understanding of the device working mode can help to identify the best device for the specified treatment, avoid unpredictable behaviours, and ensure that treatment efficiency remains unaffected. A precise and stable flow rate of dental powder is vital for cleaning sensitive areas including exposed dentine. Indeed, inconsistency in powder delivery to delicate tooth surfaces causes over-treatment and significant damage to these sites during high consumption peaks.

GBT treatment also includes the treatment of deeper periodontal pockets with powder using a special subgingival nozzle. The current recommended treatment time is 5 seconds powder projection per pocket. According to these results, to enhance the treatment efficiency, a new recommendation time of 7 seconds would ensure the best treatment using the table-top E1. In conclusion, this study helps to understand the working behaviour and subsequent powder delivery of devices with intense outbursts, both during start-up and during treatment. The study findings may help to prevent over-treatment and adverse impacts on clinical outcome.

THE FUTURE OF PREVENTION

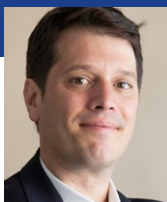
Oral medicine and prevention are the future of dentistry. The optimisation of air-polisher powder consumption is key to providing best oral prophylaxis. This research highlights the huge differences in powder consumption of different air-polisher devices, which is vital for performing pleasant GBT. It provides important insight into how differences between devices can clinically impact the user and patient treatment.

Only the AIRFLOW® Prophy Master, developed by the EMS Research Center in collaboration with scientists and clinicians, was shown to carry out precise powder delivery. This device guarantees a high-quality GBT treatment, with predictable and repeatable behaviour, while delivering best-in-class results. Due to its superior air-polishing performance, this quality standard is now called AIR-FLOWING®.

Behind the Research



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Research Objectives

A novel method was developed to better understand the performance characteristics of air-polishing devices for effective and minimally invasive oral prophylaxis.

Detail

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Bio

Dr Marcel Donnet is a chemical engineer with a PhD in Powder Technology. He has been carrying out research for more than 20 years in interdisciplinary domains including powders, fluids, chemical, medical, and dental technologies. His passion is to find the best clinical option for both user and patient.

Dr Maxime Fournier is a human-centered technologist with a strong passion for disruptive improvement of patients' and clinicians' lives. He has a PhD in Bioengineering and focused his career on pioneering MedTech challenges. He is currently the Head of Technology and Innovation at Electro Medical Systems SA.

Patrick Schmidlin is Professor and Head of the Division of Periodontology and Peri-implant Diseases at the Center

of Dental Medicine at the University of Zurich. He is a passionate clinician and researcher.

Professor Dr Adrian Lussi holds a Master's degree in Chemical Engineering, and Dr Med Dent, Professor from the University of Bern (CH) and Freiburg (D). He has over 500 publications and is editor or co-editor of 15 books in prevention and operative dentistry. He holds several awards in Dentistry.

References

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Personal Response

Could the results of this research change the manufacturing of air-polishing devices in the future?

Prevention is better than cure! This applies in particular to dentistry: modern prevention can not only prevent caries, gingivitis, and periodontitis, it can also make a significant contribution to our health more generally (for example by preventing diabetes, cardiovascular disease, etc). Good health begins in the mouth!

Prevention focuses on the removal of pathogenic dental plaque (biofilm management). The best biofilm management today is achieved with AIRFLOW® technology. The fine-tuning of powder waterjet devices is the key to success here.

Our research group has developed an innovative method to scientifically evaluate the requirements for powder delivery stability. Only continuous powder delivery ensures perfect biofilm removal. Our method shows that only EMS devices (eg, the AIRFLOW® Prophylaxis Master) can provide optimal biofilm removal with the required controlled powder delivery. This quality standard is now called AIR-FLOWING®.

