

New Technologies Shaping the Future of Oral Hygiene

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Understanding the efficiency of various toothbrush technologies is essential for achieving optimal oral health. **Dr Ralf Adam**, who leads a dedicated team at Procter & Gamble in Germany, is keen to investigate the complexities of these technologies. His team have provided new insights into the best toothbrush types for plaque removal and the maintenance of gum health. By highlighting the importance of informed oral care decisions and ongoing research, this vital research works towards ensuring everyone can achieve a brighter, healthier smile.

Unveiling the Culprit Behind Poor Oral Health

Dental plaque emerges as a significant yet often misunderstood player in the intricate world of oral health. Composed of bacteria, saliva proteins, and remnants of food, dental plaque stubbornly adheres to tooth surfaces, forming a sticky, colourless or pale-yellow film. Several key characteristics of the dental plaque stand out. For example, its continuous formation, its function as a repository for harmful bacteria, and its critical role in the development of many prevalent diseases, in particular gum or periodontal diseases. If neglected, plaque build-up can lead to problematic consequences such as bleeding gums, gum recession, and even tooth loss. Dr Ralf Adam at Procter & Gamble in Germany leads a team of researchers working to understand the most effective strategies for controlling plaque build-up, which in turn helps with the prevention of oral and periodontal diseases and promotes better oral health.

What Are the Periodontal Diseases?

Periodontal diseases include a range of conditions that affect the supportive structures of the teeth. *Gingivitis*, the earliest stage of periodontal disease, manifests as inflammation of the gums accompanied by frequent bleeding due to the accumulation of dental plaque. While *gingivitis* is reversible with effective self-care and regular dental professional guidance, many patients accept bleeding as normal even though it is a key sign of the disease. If left untreated, it can progress to a chronic inflammatory disease known as *periodontitis*, which is a more serious and irreversible form of this disease that can cause loss of supporting bone that surrounds the tooth and tooth loss. *Periodontitis* has also been associated with systemic inflammatory diseases (e.g., diabetes,

cardiovascular disease). In addition to their impact on health, periodontal diseases also have a high economic burden on society and the environment.

The key to preventing periodontal diseases is daily plaque control which can be achieved via toothbrushing. Nowadays, many different toothbrushes are available ranging from manual to different types of electric toothbrushes. The team at Oral-B have spent more than 30 years investigating the differences between toothbrush technologies in their ability to remove plaque and prevent diseases.

Researching the Most Effective Toothbrush Technology

To understand whether there are meaningful differences between the types of toothbrushes, the team first needed to examine the various technologies underpinning electric toothbrushes. Manual toothbrushes are the most widely used around the world, but population-based research has shown manual toothbrush users have more oral disease and tooth loss compared to electric toothbrush users. Two main types of electric toothbrushes exist – sonic toothbrushes and oscillating-rotating toothbrushes. While sonic toothbrushes move side-to-side and have a more traditionally shaped rectangular or elliptical brush head, the oscillating-rotating toothbrushes oscillate and rotate, and their brush head is round. There are also advanced power toothbrushes that can support better brushing behaviours with additional features like timers, pressure sensors, and coaching apps.

In 2020, Oral-B introduced an advanced oscillating-rotating toothbrush called Oral-B iO with a linear magnetic drive to more efficiently channel energy to the bristle tips, enhancing plaque



removal. Currently, it is the most advanced oscillating-rotating toothbrush on the market.

Dr Adam and his colleagues compared the results from existing studies to draw conclusions about the effectiveness of different types of toothbrushes in removing plaque and maintaining optimal gum health. More specifically, they compared manual, sonic, traditional oscillating-rotating, and Oral-B iO oscillating-rotating toothbrushes.

Such statistical comparisons, known as meta-analyses, stand out as a particularly strong type of scientific evidence due to their ability to summarise and analyse the results from multiple independent studies on a given topic. By pooling together results from various studies that meet a specific set of criteria, meta-analyses provide a comprehensive overview of the existing research, offering more robust and reliable conclusions compared to individual studies. They take into account not only patterns but also inconsistencies across studies. In this case, a meta-analysis helped the researchers to refine their understanding of toothbrush effectiveness.

Making self-care decisions based on published scientific evidence is crucial for maintaining and improving our own health outcomes. In the context of oral health, numerous products and practices claim to promote the most effective dental hygiene. It, therefore, becomes essential to rely on rigorous scientific evidence to guide decision-making. Consequently, when making self-care decisions, relying on evidence from well-conducted meta-analyses ensures that choices are grounded in the most rigorous and comprehensive scientific research available.

What Did the Meta-analysis Reveal?

Dr Adam and his team evaluated the performance of manual, sonic and oscillating-rotating toothbrushes across 21 *gingivitis* clinical trials and 25 clinical trials on plaque removal conducted between the years 2007 and 2022. Three different experts from Dr Adam's team assessed the studies and compared the performance of the toothbrushes on plaque removal and gum health benefits using data for each individual study participant.

The meta-analysis results showed that the Oral-B iO oscillating-rotating toothbrush was the most effective. 88% of participants with early gum issues (*gingivitis*) who used it transitioned to having healthy gums by the end of the studies. This transition was also 50% faster (or 6 weeks earlier) than the transition to healthy gums when using a manual toothbrush and 33% faster (or 4 weeks earlier) than when using a sonic toothbrush. Participants with gum disease who used an oscillating-rotating toothbrush (iO or a traditional model) had 9.5 times better odds of achieving healthy gums compared to using a manual toothbrush and 2.2 times better odds than using a sonic toothbrush.

The results of this meta-analysis were clear – the electric toothbrush is more effective than a manual toothbrush. When assessing different types of electric toothbrushes, the oscillating-rotating ones are more effective than a sonic toothbrush. And the specific type of oscillating-rotating toothbrush, the Oral-B iO, takes the lead overall.



Periodontal diseases include a range of conditions that affect the supportive structures of the teeth. These diseases do not only impact an individual's oral health negatively, but they also have a high economic burden on society and the environment.



The most advanced oscillating-rotating iO toothbrush was the most effective, with roughly 88% of participants who used it transitioning from gum disease to healthy gums.

Brushing Behaviours and Their Role in Plaque Removal

Effective plaque removal and prevention of *gingivitis* are not solely about the type of toothbrush. How people brush matters, too. Despite the advice to brush with fluoride toothpaste twice a day for two minutes, manual toothbrushes leave behind up to 50% of plaque. Even when people switch to electric toothbrushes, they might still not brush properly. For instance, they might forget to clean inside surfaces, specifically the ones towards the tongue or neglect their back molar teeth. Another common mistake is not spending enough time brushing each part of the mouth evenly.

As part of their research to understand brushing behaviours, Dr Adam and his team looked at the two most effective toothbrushing technologies – a traditional oscillating-rotating toothbrush and the Oral-B iO toothbrush – without the use of interactive coaching features. They compared which toothbrush cleans better, especially in the hard-to-reach areas. They invited 41 participants to their research centre on three occasions and observed their brushing habits. Participants brushed their teeth using two different models of toothbrushes in sequential order, using the traditional oscillating-rotating toothbrush at the first visit and the Oral-B iO at the second and third visits. The instructions to brush for 2 minutes were the same for both toothbrushes. The researchers compared the effectiveness of plaque removal as well as how easy it was to reach neglected areas in the mouth.

After just one use, the Oral-B iO removed 41% more plaque than the traditional oscillating rotating electric toothbrush. This difference became even more pronounced after a subsequent week of using the Oral-B iO toothbrush at home. When comparing the brushing habits in hard-to-reach areas, the team found that using Oral-B iO enabled participants to brush more uniformly across their teeth and mouth surfaces. The results from this study were

similar to the results from other models of these next-generation oscillating-rotating toothbrushes that show people naturally brush more thoroughly when using iO models, particularly cleaning the back (lingual) side of teeth better, even without any coaching or instruction. In consumer research, participants reported feeling a pleasant gliding sensation when using the iO, and the team hypothesised that it plays a role in the improvement of users' brushing habits.

Advancing Oral Health Through Assessing the Technologies

Maintaining effective daily toothbrushing is essential for preventing gum diseases. Dr Adam's research highlights significant differences in toothbrushing technologies, with the Oral-B iO toothbrush surpassing traditional oscillating-rotating, sonic, and manual toothbrushes in effectiveness. Not only does the Oral-B iO lead to better gum health outcomes for more people, but it also achieves these results faster. Another advantage of using oscillating-rotating toothbrushes, specifically the Oral-B iO, is its improvement of brushing behaviours. The results of these studies are in line with other published results – all supporting the superiority of the new generation of oscillating-rotating toothbrushes.

Many oscillating-rotating electric toothbrush models come with features like timers, pressure sensors, and interactive displays to guide people to brush their teeth more evenly, including tricky spots. Extensive research, including video analysis of toothbrushing habits and Artificial Intelligence algorithms, led to the creation of these features, which are like friendly reminders to keep all parts of the mouth clean and healthy. Data from over 400,000 actual oscillating-rotating toothbrush users around the world shows these features improve brushing behaviours.



Ongoing research and innovation in oral care technologies are essential for continuously improving oral health outcomes. By understanding which types of technologies are most effective in promoting proper oral care habits, we can empower individuals to take control of their oral health and overall well-being. As researchers continue to explore and develop new advancements, it is crucial to prioritise solutions that make maintaining good oral hygiene effortless and accessible to all. Leading these research efforts is Dr Adam's team, which continues to assess different types of technologies and consider the impact of good oral health on overall well-being.



MEET THE RESEARCHER

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Dr Ralf Adam obtained his PhD in 1994 from the University of Hohenheim, Stuttgart, Germany, after which he moved to Berlin, where he spent three years as an Assistant Professor at the Humboldt University. He joined Procter & Gamble, Kronberg, Germany, in 1997 as the scientist responsible for Product Safety and Regulatory Affairs of Baby Care products. Since 2009, he has overseen clinical research for manual and electronic toothbrushes worldwide. His current position is a Senior Director Research Fellow, but his other experience includes working as a Principal Investigator, Sponsor-Investigator, and Clinical Scientist in more than 200 clinical studies. He also regularly serves as abstract reviewer, symposia chair, and programme chair of the International Association for Dental Research, where he was previously President and Vice President of the Oral Health Research Group.



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FURTHER READING

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