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Electric rotation-oscillation, Sonic and Solar-powered Toothbrushes: Choices for Better Protecting Your Teeth

Abstract

The toothbrush has been continuously improved to promote healthier teeth. The modern, manual toothbrush cleans teeth more effectively than traditional instruments such as using fingers, sticks and twigs. Scientists and engineers have recently invented more advanced toothbrushes such as electric rotation-oscillation, sonic, and solar-powered toothbrushes. These advanced toothbrushes do more than scrub teeth with a plastic handle; they promote healthy teeth with less effort and better results by using their own cleaning mechanisms. Despite the current effectiveness of these advanced toothbrushes, these toothbrushes might be further improved in the future.

Introduction

Since adult teeth are not naturally replaceable, it is imperative to protect them with the proper resources [1]. This preventative care includes the removal of plaque, a type of bacteria that may accumulate and cause cavities and numerous forms of periodontal disease, such as receding, bleeding gums or tooth loss. Daily use of the toothbrush is a simple and effective means of

advocating for dental health. It cleans plaque using the small, repetitive motions of the toothbrush's bristles. For this task, the familiar manual toothbrush with nylon bristles and a plastic handle is adequate; however, scientists and engineers have invented toothbrushes with advanced technologies that claim to remove plaque more effectively. This article aims to verify the truth of these claims by examining the logic and uses of such new technologies in toothbrush.

History

Although the modern toothbrush was invented relatively recently, our ancestors had their own ways of cleaning teeth. The human fingers were considered to be the first toothbrush [2]. Ancient Egyptians made a "tooth powder" dating back to 5000 BC. The powder consisted of ash from ox hooves, myrrh, eggshell fragments and pumice [2]. The first recorded device used for teeth cleaning was known as a "chewing stick" [2]. It was used around 3500-3000 BC in ancient Babylonia, and somehow flowed into China [2]. As shown in Figure 1, this stick was similar to a twig with a frayed end. Ancient Chinese literature depicts the use of a chewing twig chosen from aromatic trees (also used to freshen breath) [2]. Afterwards, the Chinese also developed the first actual brush that resembles modern toothbrush in physical shape [2].



Figure 1: A chewing stick

<http://www.incisorsandmolars.com/dental-education/toothbrush-history.html>

Chinese literature from 1223 AD indicates that monks used a brush made of horsetail hairs to clean their teeth (Fig 2). In time, this type of brush was known by the world, and different animal hairs were used for the brush head. During the Middle Ages, boar hairs were popular in Asia, while horse hairs prevailed in the West because they were softer than boar hairs [2].



Figure 2: Early toothbrush found in China

<http://kewai.xiaojiaoshi.com/baike/88.html>

The first recorded use of the actual word "toothbrush" was in 1690 AD [2]. A man named Anthony Wood used the word "toothbrush" in his autobiography [2]. In 1780, a man named William Addis became the first person to mass-produce toothbrush [2]. Ten years earlier, when he was in jail, he felt the method for cleaning teeth there could be improved [2]. Addis took a small animal bone, made some holes in it, tied some hair bristles he got from a guard through the holes, and glued it all into the holes [2]. The brush he made was easy to make and use. After his release from jail, Addis turned his invention into a business by producing the "toothbrush" he invented in jail [2]. Today his company, Wisdom Toothbrushes, is still present. In 1937, Du Pont Laboratories invented nylon, and in the following year, the first nylon bristles toothbrush was

invented—they remain prominent today [2]. Compared with animal hairs, nylon material less easily retains bacteria than animal hairs, which became the main reason for its wide use [2].

Though the toothbrush's overall design has remained consistent since the 1780s, modifications have been made to specifics of the design in hopes of improving efficacy. The shape of the brush head is an example of this. Nowadays, consumers can select from toothbrushes that have circular bristles, bristles of varying height, or even bent brush heads, similar to a dental mirror. Other significant developments have come with the increasing availability of electric toothbrushes. With heightened consumer expectations and demands, toothbrush models that utilize more advanced technologies have been created. These include toothbrushes with electric rotation-oscillation, sonic power, and even solar-powered technologies. These three specific types of electric toothbrushes and their potential efficacy are further explained below.

Advanced Toothbrushes: Electric Rotation-Oscillation, Sonic and Solar-powered Models

Electric Rotation-Oscillation Model: Rotary motion and back-and-forth motion

An electric rotation-oscillation toothbrush is a device that uses an electric battery to automatically move the bristles [3]. In Figure 3, the electric rotation-oscillation toothbrush and its major components are shown.



Figure 3: The electric rotation-oscillation toothbrush and different parts that compose it

<http://www.explainthatstuff.com/electrictoothbrush.html>

The brush bristles of the electric rotation-oscillation toothbrush are removable [3]. The removable brush plugs into a small hole at the top of the brush handle. This hole connects the bottom of the brush to a gear and cam unit that rotates the toothbrush [3]. This enables the removable brush to get electricity from internal electric motor [3]. There are two motions going on at the same time once the power is turned on [3]. First, removable bristles begin to spin, causing a high-speed rotary motion [3][9]. The gear then converts the rotary (spinning) motion into back-and-forth brushing motion that cleans your teeth even more effectively [3][9]. On average, this brushing motion creates 2500 to 7500 strokes per minute [3][9]. The cam and gear works a bit like this very simplified graph shown in Figure 4. The green wheel, driven by the motor, is rotating clockwise at high speed, while the black lever is repeating back-and-forth motion. Thus, a combination of these two motions forms a circle-like motion, enabling a larger scrubbing area.

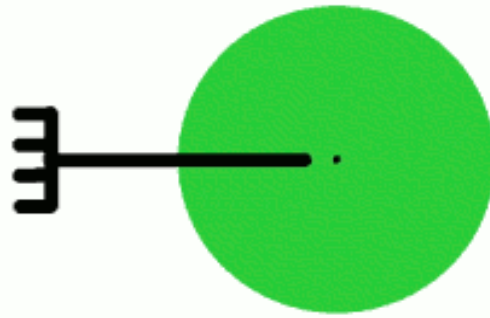


Figure 4: How scrubbing action of cam and gear works on the surface of teeth

<http://www.explainthatstuff.com/electrictoothbrush.html>

(Notes: This graph is originally an animation in gif format, but Word cannot load gif format)

Sonic Model: Sonic technology relies on a high rate of vibrational speed

Sonic toothbrushes are one of many electric toothbrush models following the electric rotation-oscillation toothbrushes [4]. Although the sonic toothbrush might resemble electric ones in terms of physical outlook, they work slightly differently. The sonic toothbrush has a brush head that vibrates more than 30,000 strokes per minute [4][9]. The tooth-cleansing ability of the sonic toothbrushes is based on two separate mechanisms. One is a conventional mechanism, and the other is applying fluid dynamics [4][9]. The conventional part of the cleaning action is produced by the scrubbing action of bristles on the surface of a user's teeth, which is similar to the electric rotation-oscillation toothbrush. However, the difference is that the sonic toothbrush does not have the spinning motion. Thus, it might not have a spinning removable brush head [4].

The second mechanism of the sonic toothbrush creates a secondary cleaning action, which is generated by the rapid speed with which the brush head vibrates [4][9]. This vibrating action creates pressure waves and shear forces in the liquids that surround your teeth [4][9]. As shown in Figure 5, it also generates tiny bubbles that are propelled against teeth surfaces where plaque has built up [4]. Moreover, this cleaning effect covers a distance of up to 4 millimeters beyond where the bristles of the sonic toothbrush actually touch [4]. Therefore, the vibrating effect is able to disrupt plaque in areas that are hard to reach such as gaps between teeth and areas below the gum line (Figure 5) [4].

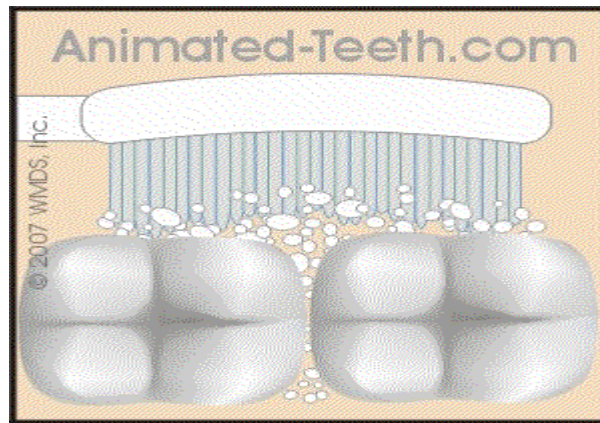


Figure 5: Tiny bubbles generated by vibrating action of the sonic toothbrush

http://www.animated-teeth.com/electric_toothbrushes/t3_sonic_toothbrushes.htm

Solar-powered Model: Generating electrons

Solar-powered toothbrushes are the latest model compared with the other two models discussed above. As shown in Figure 6, the three main components of the solar-powered toothbrush are the solar panel, lead wire and semiconductor. In Figure 6, the graph also shows how the cleaning mechanism of the solar-powered toothbrush works. When light strikes the solar panel, electrons

e^- are generated [5]. These electrons move along the lead wire from the negative pole toward the semiconductor. On the other hand, when light strikes the semiconductor, electrons e^- are generated. Then, these electrons e^- and e^- move to the inside of the mouth through saliva, a transmitter of electrons in the brush head [5]. Generally, these electrons react with acid in the mouth, which creates a chemical reaction that breaks down plaque and kills bacteria [5]. To be more specific, these electrons remove the hydrogen ion H within plaque, which allows plaque to break down [5]. As a result, dental plaque is easier to remove. The solar-powered toothbrush does not require toothpaste, like other toothbrush models do [6]. Although people can still use toothpaste, the solar-powered toothbrush removes plaque effectively using only electrons [6].

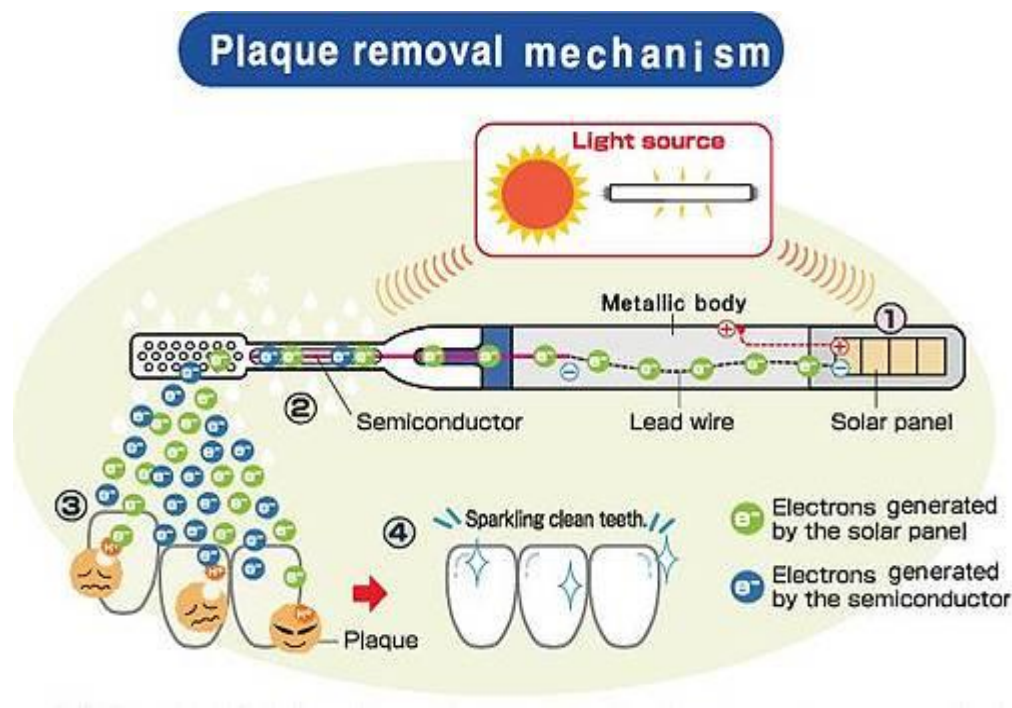


Figure 6: Three Main components of the solar-powered toothbrush and how they work

http://doctordalai.blogspot.com/2010_09_01_archive.html

The Effectiveness of the High-Tech Toothbrushes

The three toothbrush models have different mechanisms and technology to clean teeth more effectively. But are these electric toothbrushes really more effective than manual toothbrushes? If so, which specific type?

In comparing the electric rotation-oscillation and the sonic toothbrushes, the biggest part of their cleaning actions is the scrubbing action of the brush's bristles on the surface of teeth [4][9]. The effectiveness of scrubbing is based on the brush strokes per minute that these types of brushes generate [4][9]. Compared with the number of brush strokes per minute generated by a manual toothbrush, which is generally around 300 strokes per minute, the electric rotation-oscillation toothbrush can work at a rate of 2500 to 7500 strokes per minute, and the sonic model is able to work at a rate more than 30000 strokes per minute [4][9]. However, although the sonic toothbrush has the secondary mechanism of cleaning by applying fluid dynamics, there is no research that has definitely proven its cleaning effectiveness [4][9]. In comparison with the electric rotation-oscillation brush, the additional benefit the sonic model can provide might be more, or at least the same, since the electric rotation-oscillation toothbrush does not have a secondary mechanism for cleaning [4][9]. However, it is still the high rate of scrubbing action and the number of strokes the sonic toothbrush can produce per minute that sets it apart from the manual and the electric rotation-oscillation ones [4].

Although many scientists and engineers argue that electric toothbrushes are not superior to manual ones, there are actually counter-arguments stating otherwise [7]. Research conducted by Professor Bill Shaw of the University Dental Hospital in Manchester demonstrates that an electric rotation-oscillation toothbrush can remove around 7% more plaque and led to 17% less

gum disease than a manual toothbrush [7]. Therefore, electric toothbrushes are at least as effective as manual ones.

The solar-powered toothbrush, alternatively, does not have outstanding strokes numbers per minute as the electric ones do. Indeed, the chemical reactions of electrons are a key cleaning mechanism [5]. The chemical reactions also allow the solar-powered toothbrush not to necessarily use toothpaste as all the other models do [6]. Moreover, the solar-powered toothbrush does not use a battery as a source of electricity [5]. Rather, just like its name, the solar-powered toothbrush mainly utilizes solar energy to produce electrons, which is environmentally conscious [5]. For people who stay up late at night, a small amount of light is enough to make solar-powered brushes work, which is reasonable since we usually need light anyway to brush teeth at night with any type of toothbrushes [6]. More importantly, the cleaning mechanism of the solar-powered toothbrush is very effective despite its complex process of producing electrons. There was a test called S.mutans (cavity-causing bacteria) elimination test [8]. In the test, researchers immerse a common toothbrush and a solar-powered toothbrush into S.mutans bacteria cultivation liquid for three minutes, and after that, let it be for 48 hours. The result suggests that the solar toothbrush suppressed the proliferation of this bacteria, which might equivalently imply its higher effectiveness of removing plaque [8].

After comparisons, it is clear that the scrubbing action is still the most reliable way of removing plaque on teeth for electric toothbrushes. The sonic toothbrush has unobvious cleaning effects with fluid dynamics, while the reaction of electrons is more effective than the scrubbing motion of the solar toothbrush. This shows that the primary cleaning mechanism of the solar toothbrush, different from electric ones, focuses more on the chemical reaction instead of scrubbing teeth.

Overall, solar-powered toothbrushes have received greater acclaim from scientists than the other two models. This might imply that more scientific research on secondary cleaning mechanisms is imminent to replace the scrubbing motion to be the main cleaning mechanism of toothbrush.

Conclusion

Although there might be certain inadequacies in every toothbrush model, it is probably safe to assume that these advanced electric toothbrushes are more effective than manual ones. Since every toothbrush has the basic scrubbing function, modern toothbrushes, with more advanced technologies equipped as secondary cleaning mechanisms, have extra cleaning impacts on teeth. Moreover, the solar toothbrush might be the best choice among the three modern toothbrushes because it is not only environmentally conscious, but also more effective in removing plaque by generating electrons. As technology progresses, further toothbrush developments may be in the near future. For instance, there might be a combination of sonic and solar-powered toothbrushes. By taking good features of these two, a newly-invented toothbrush might provide a faster vibrating rate with more effective chemical reaction caused by electrons. These double effects might then greatly save our time with even higher efficiency of teeth cleaning. This might imply that toothbrushes are still evolving toward a more perfect device, with different technologies and new combinations of secondary cleaning mechanisms added. It might not only be a sign of toothbrush improvement, but also a signal of scientific development and human determination for a better life. We have no idea whether this assumption will come true in the future, but we hope that exciting day is not too far away.

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