Safety Aspects of Ultrasonic Toothbrushes

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It is commonly understood that biofilm is the main etiological factor of caries[1]. Despite this fact, it is still a challenge to get patients to achieve proper oral care through the removal of biofilm inside the oral cavity. With the goal of finding an easier and more effective method of biofilm control, the ultrasonic toothbrush was invented in the early 1990's and was approved for home use by the United States Food and Drug Administration (FDA) in 1992. It has since been proven to be both effective and safe in daily home use.

The author's personal experience with ultrasound technology used in a toothbrush began in 1998, being one of the research professors at the University of Tokyo conducting research on the effectiveness of ultrasound for the removal of *Streptococcus mutans* from tooth enamel[2]. Since the findings of this research were published in 1999, the author has remained involved in the study of biofilm control and has witnessed the evolution of the ultrasonic toothbrush and its growth in popularity over the years. A literature review has not revealed any documented instances where the issue of safety regarding the use of this ultrasound technology in oral care has been questioned. On the contrary, the efficacy and safety of the ultrasonic toothbrush has been well documented. Before a new technology is brought to market to be used by patients for biofilm control, in addition to demonstrating efficacy, the product must also prove its safety. Clinicals proving the product's safety are a prerequisite in order to get approval from government agencies. The objective of this article is to provide a summary of several documented studies demonstrating that the use of ultrasound at a specific frequency and power output is an effective and safe method for biofilm control.

To understand how the ultrasonic toothbrush works and why it is safe to use it is important to recall the characteristics of sonic (sound) energy. Sound can be understood as the vibrational energy of molecules in a medium. Sound propagation involves the transfer of this vibrational energy from molecule to molecule as the sound propagates through the medium[3]. This means that ultrasound can only propagate in solids, liquids and gases. In a vacuum, transmission of sound cannot occur[4].

Frequency of sound is determined by the speed of oscillations of the

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molecules which propagate it. It is measured using a unit called the Hertz (Hz), defined as the number of oscillations which a molecule makes per second. The human ear can perceive sounds with a frequency of 20 Hz to 20 kHz. Ultrasound has a frequency above the 20kHz upper limit of human hearing[5]. Sound intensity, described as the amplitude of a sound wave, describes the amount of energy that a sound delivers. Ultrasonic toothbrushes on the market today use ultrasonic energy of approximately 1.6 MHz, emitting waves of low intensity. This is the frequency that was approved for use in a toothbrush by the United States Food and Drug Administration (FDA) in 1992. The safety criterion used by the US FDA and most specialists throughout the world is to ensure that surrounding oral soft or hard tissue does not increase in temperature by more than 1°C during prolonged continuous use.

Ultrasound, like all forms of sound, is a form of mechanical vibration, not electromagnetic radiation. It has not been shown to have any correlation with ionizing radiation. Genetic and somatic effects associated with ionizing radiation therefore do not occur. Consequently, children and pregnant women can safely use ultrasound[6].

The same frequency of 1.6 MHz used in the brush also is used as ultrasonic treatment for skin cuts [7], fractures [8, 9], and bone regeneration [10]. Clinicals also show that ultrasound can prove beneficial in the treatment of recurrent ulcers, gingivitis and periodontitis[11,12].

In 1994, Terezhalmy et al [13] investigated the safety of ultrasound. The study evaluated a total of 54 patients during a period of one month. They were divided between those who used a manual toothbrush and those who used an ultrasonic toothbrush. Clinical visits were made on the 15th day and 30th day. Patients were evaluated for changes in the tongue, hard and soft palate, gums, buccal mucosa, sublingual area and teeth. No evidence of adverse effects was found. As a matter of fact, they concluded that the ultrasonic toothbrush was more effective in reducing gingivitis and gingival bleeding by day 30 of the study and it is clearly more successful in removing plaque without evidence of adverse effects.

In 2007, Goyal [14] evaluated the safety of an ultrasonic toothbrush compared to a manual toothbrush in patients with mild to moderate gingivitis. The study evaluated a total of 53 individuals. 30 days after completion of a questionnaire a periodontal examination was performed. There were no adverse effects reported with the use of the ultrasonic toothbrush. The ultrasonic toothbrush was found to have a significantly greater reduction in gingivitis when compared with a manual toothbrush.

In 2008, Sorensen[15] ran another in vitro study to evaluate and compare the safety of an ultrasonic toothbrush to a manual toothbrush on the surfaces of natural and restored teeth, crowns, and cemented orthodontic brackets. The study showed that there was no significant difference between the safety of any of the toothbrushes, and that each of them was effective for daily biofilm control. They concluded that the new ultrasound toothbrush was found to be safe on natural tooth surfaces and restorative materials, as established in comparison to positive and negative controls. Furthermore, no safety concern related to orthodontic bracket or dental crown retention was identified with any treatment.

Costa et al.[16] reported in their literature review about comparison of

manual versus sonic and ultrasonic toothbrushes that the use of high frequency brushes (sonic and ultrasonic) has been considered safe and has produced satisfactory results.

Terezhalmy et al.[17] conducted a study with 44 patients using a manual or ultrasound toothbrush twice daily for six months. Clinical measurements as plaque index, gingival índex and bleeding index were recorded at follow-up visits at 15 days, 30 days, and 6 months. They concluded that when used as part of a daily oral hygiene regimen, the ultrasonic toothbrush was significantly more effective than a conventional toothbrush over a 6-month period and should be a safe and effective adjunct to professional instrumentation.

Based on studies in the literature, and the absence of any reported adverse effects since the ultrasound toothbrush was introduced in 1992, it is reasonable to conclude that the ultrasonic toothbrush using a frequency of 1.6 MHz is a safe and effective alternative for biofilm control and can be used daily by patients in performing their oral hygiene. ■

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