

CHAPTER 1

Design and Development of a Bluetooth-Enabled Electric Toothbrush for Children

*Alrio Chaves Fernandes**, *Veena Benakatti*** and *Anand Badavannavar****

ABSTRACT

Background: Establishing good oral hygiene habits during childhood is vital for preventing cavities and gum diseases later in life. However, children often struggle to effectively remove plaque with manual toothbrushes due to poor technique, limited dexterity, low motivation, and short brushing times.

Objective: To create, develop, and showcase a child-friendly ultrasonic electric toothbrush that includes Bluetooth audio features to improve brushing effectiveness and engagement.

Materials and Methods: We designed an ultrasonic electric toothbrush that features a piezoelectric vibration system, various brushing modes, and Bluetooth Low Energy (BLE) connectivity. This device streams audio from a paired smartphone to a built-in speaker. We performed bench tests to evaluate its performance and battery life. A demonstration in a school setting involved 500 children to assess usability and acceptance.

Results: The toothbrush produced consistent ultrasonic vibrations across all modes without needing manual pressure. The Bluetooth connection was reliable, and the audio output was clear. The rechargeable battery lasted about six to eight hours of use per charge. Children showed a high level of interest and excitement during the demonstration at school.

Conclusion: We successfully developed and demonstrated a patented Bluetooth-enabled ultrasonic electric toothbrush for children. The combination of ultrasonic cleaning and audio features may boost brushing habits and motivation among kids. Further studies are needed to evaluate long-term oral health results.

Keywords: Ultrasonic toothbrush; Bluetooth audio; Pediatric oral hygiene; Smart toothbrush; Plaque control.

1.0 Introduction

Good oral hygiene habits developed during childhood are crucial in preventing cavities, gingivitis, and future gum disease.¹

**Corresponding author; Undergraduate Student, Bachelor of Dental Surgery, KLE VK Institute of Dental Sciences, Belagavi, Karnataka, India (E-mail: alriochavesfernandes@gmail.com)*

***Reader, Department of Prosthodontics & Crown and Bridge, KAHER'S KLE VK Institute of Dental Sciences, Belagavi, Karnataka, India (E-mail: kenganalveena@gmail.com)*

****Professor, Department of Orthodontics and Dentofacial Orthopaedics, KAHER'S KLE VK Institute of Dental Sciences, Belagavi, Karnataka, India (E-mail: anand_ortho@yahoo.co.in)*

Manual tooth brushing requires the right technique, pressure, and duration, which children often do not manage effectively.² As a result, controlling plaque in kids remains a challenge. Powered toothbrushes show better plaque removal and gum health benefits compared to manual brushing, especially for those with limited dexterity.^{1–3} Ultrasonic toothbrushes work by creating high-frequency vibrations that disrupt dental biofilm with minimal movement, making them a good fit for children and those with gum sensitivity.^{4,5}

Recent progress in digital health and smart oral care tools has introduced mobile apps, audiovisual feedback, and music to help increase motivation and compliance in kids.^{6–9} In addition, maintaining toothbrush hygiene, managing bristle wear, and the ability to clean or replace brush heads are key to effective cleaning and good oral health.^{10,11}

This study outlines the design and development of a patented ultrasonic electric toothbrush for children that includes Bluetooth audio capability and features aimed at improving brushing effectiveness and user engagement.

2.0 Materials and Methods

2.1 Device design and functional components

The toothbrush was developed in collaboration with Assalihin HealthCare Solutions LLP, Belagavi. Its main mechanism includes an ultrasonic vibration module using a piezoelectric transducer to generate high-frequency oscillations that disrupt plaque.⁴ An electronic control unit manages vibration strength and allows selection of slow, medium, and fast brushing modes. We included electronically programmed clockwise and counterclockwise motion patterns to improve coverage on tooth surfaces. Bluetooth Low Energy (BLE) technology enables wireless pairing with smartphones, allowing for audio streaming to a small speaker located in the toothbrush handle.^{6,7}

2.2 Hygienic and mechanical features

The toothbrush head can be detached and washed. Interchangeable rubber caps for bristles were designed to improve safety, reduce soft-tissue injury, and engage children. The handle features an ergonomic shape that suits small hands, promoting ease of use.

2.3 Power supply

The device runs on a rechargeable lithium-ion battery and can be charged through a wired port. Bench tests showed an average use time of six to eight hours per charge.

2.4 School-based demonstration

We conducted an oral hygiene awareness and demonstration program at Regina Mundi High School, Chicalim-Vasco, Goa, with around 500 students. The children received

instructions on proper use and observed live demonstrations of the toothbrush. The initiative earned a Certificate of Appreciation from school authorities. No clinical measurements were taken.

3.0 Results

The ultrasonic toothbrush delivered steady and consistent vibrations during testing and demonstrations without needing brushing pressure.^{4,5} All brushing modes worked as expected. Bluetooth connectivity was stable throughout testing, and audio from the built-in speaker was clear. The detachable brush head and interchangeable caps were easy to put on, take off, and clean. Battery tests showed an operational time of around six to eight hours per charge. During the demonstration at school, children expressed significant interest and enthusiasm for the device.

4.0 Discussion

The results align with existing research showing that powered and ultrasonic toothbrushes provide better plaque control than manual brushing.^{1–3} Ultrasonic technology lessens the need for skill and pressure while brushing, which benefits young users.^{4,5}

Music and audio-guided brushing have been proven to reduce dental anxiety, increase brushing time, and enhance compliance in children.^{8,12} Smart toothbrush systems, which include digital or audio guidance, have shown positive effects on behavior in children's oral health programs.^{6,9}

The design of this device, which includes replaceable and washable parts, addresses issues related to bristle wear and contamination that can lower brushing effectiveness.^{10,11} The school demonstration emphasizes the device's acceptability and its potential in community-level oral health education. However, randomized controlled clinical trials are needed to determine long-term benefits.

5.0 Conclusion

We developed and demonstrated a patented Bluetooth-enabled ultrasonic electric toothbrush tailored for children. This device combines ultrasonic plaque disruption, interactive audio engagement, multiple brushing modes, and hygienic replaceable parts. Registration with the India Book of Records and positive feedback from a 500-student demonstration in Goa highlight its uniqueness and importance. This smart toothbrush offers promising support for improving children's oral hygiene practices.

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