

## Powered Tooth Brush - A Review

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### ABSTRACT

Regular mechanical removal of bacterial plaque is essential to prevent the onset of dental diseases such as dental caries, gingivitis and periodontal disease. Oral hygiene practices involve the thorough daily removal of dental plaque and debris using intra oral cleaning devices. Tooth brushes are the most commonly used oral hygiene aids. As technology advanced, powered toothbrushes came into being as an alternative to manual tooth brushing. The powered toothbrush was developed to aid people with manual dexterity problems or other physical limitations. They are available in many styles and modes of action. The early models had a simple back and forth action and were ineffective in plaque control. With the advent of newer models which incorporated the rotation oscillation action (ROA) and optional features like timer, pressure sensor and blue tooth, the popularity of powered toothbrushes increased. Nowadays, the use of powered toothbrush is indicated not only for the differently abled people but also for the general population. The superiority of powered tooth brush over manual brush in terms of plaque control and improving periodontal health is a topic of constant debate. Hence, the aim of this comprehensive review is to present an update about the current status of powered tooth brush in terms of its application in oral health and to compare with a manual tooth brush.

**Keywords-** oral health, oral hygiene, powered tooth brush, review, tooth brushing.

### INTRODUCTION

Tooth cleaning has been an integral part of oral hygiene routine across many cultures around the world from the times of antiquity. Oral hygiene practices involve the thorough daily removal of dental plaque and debris by the tooth brush without injuring the soft tissue. Tooth brushes are the most widely used oral hygiene aids. It is the principal instrument in general use for accomplishing the goal of plaque control. [1,2]

Dental plaque is the primary causal factor in dental caries, gingivitis, and periodontitis. Good oral hygiene by effective tooth brushing has a key role in oral health with the prevention of periodontal disease and caries. [1]

As many manual devices evolve into their electric counterparts, electric version of toothbrush has also been developed. The device is intended to remove adherent plaque and food debris from teeth to reduce or prevent dental disease. The very first powered toothbrushes were introduced in the 1940s. It took decades until the advantages of powered toothbrushes were accepted by the dental profession and consumers to be of considerable (clinically relevant) benefit. [3]

### HISTORY OF TOOTHBRUSH

A variety of cultures across the world have used many different materials from certain tree twigs like "Neem" and "Miswak" to bird feathers and hog hair for

cleaning the teeth .Ancient people chewed twigs from plants with high aromatic properties. Small twigs were eventually mashed at one end to increase their cleaning surface. Chewing these twigs freshened the breath and spread out fibers at the tips of the twig for cleaning the tooth and gum surfaces. Chew sticks contain antibacterial oils and tannins that may help prevent or remove plaque. The Arabs before Islam used a piece of the root of the Arrack tree because its fibers stood out like bristles; this device was called as siwak. In the seventh-century, Prophet Mohammed made rules for oral hygiene, and so it became a religious obligation. To this day the siwak, composed from aromatic types of wood, is still used. [1]

The Chinese are credited for inventing the toothbrush comprising a handle with bristles during the Tang dynasty (618-907 A.D.). The bristle brush came to Europe during the 17<sup>th</sup> century and soon was widely used. French dentists advocated the use of toothbrushes in the 17<sup>th</sup> and early 18<sup>th</sup> centuries. At the same time, pre-revolutionary American dentists were encouraging the use of bristle toothbrushes in America. Toothbrushes were first mass-produced by William Addis of Clerkenwald, England. H.N.Wadsworth patented the first American toothbrush, and companies began to mass produce toothbrushes in America around 1885.Natural bristles were obtained from hair of Hog or Wild boar. These are tubular in form and were more susceptible to fraying, breaking, contamination with microbial debris, softening and loss of elasticity. Nylon replaced the natural bristles in modern brushes in 1938. These are uniform in size and elasticity, resistant to fracture. [1,4]

#### **PARTS OF TOOTH BRUSH [1]**

- Handle- The part grasped in the handle during tooth brushing.
- Head- The working end of a tooth brush that holds the bristles or filament.
- Tufts- Clusters of bristles or filaments secured into the head
- Brushing plane-The surface formed by the free ends of the bristles or filament.

- Shank-The section that connects head and handle.
- Toe

#### **FEATURES OF A TOOTHBRUSH [1]**

- The stiffness of bristles vary based on diameter, length, number of filaments.
- Diameter of bristles: For adults- soft (0.007"), medium (0.012") and hard (0.014")
- For Children -0.005"
- Length of bristles :0.406" (adult), 0.344" (children)
- Number of filaments in a tuft : 80 - 86 per tuft

#### **ADA specification of a toothbrush [1]**

##### **Brushing surface:**

- 1-1.25 inches in length
- 2 to 4 rows of bristles
- 5/16 to 3/8 inches in width
- 5-12 tufts/row

#### **POWERED TOOTHBRUSH**

A powered toothbrush is an AC-powered or battery-powered device that consists of a handle containing a motor that provides mechanical movement to a brush head with filaments that move rapidly. The device is intended to remove adherent plaque and food debris from teeth to reduce or prevent dental disease. The powered toothbrush was introduced to motivate patients to brush correctly in terms of proper technique and duration. [3]

#### **HISTORY [5]**

1886-Powered toothbrushes were first advertised in Harper's Weekly.

1939-The prototype of the first electric toothbrush was developed in Switzerland by Dr. Phillippe- Guy Woogin, but it wasn't released until 1954.

1960- Squibb marketed the first American-made electric toothbrush called the Broxodent.

1961-General Electric introduced a rechargeable cordless toothbrush

1987-Interplak was the first rotary-action electric toothbrush for home use. This

"second generation" powered toothbrush had a uniquely rotating head and was powered by long-life/ rechargeable batteries. Increased efficacy compared to manual toothbrushes was consistently demonstrated in published studies.

1992 - Sonic-powered toothbrushes were developed and were shown to remove more plaque in comparison to manual toothbrushes, especially in long-term studies.

### GENERATIONS OF POWERED TOOTHBRUSH <sup>[1]</sup>

Generation	Description	Example
Initial(First)	Powered by electricity, battery powered, inexpensive	Broxodent <sup>®</sup>
Second	Vibrating, reciprocal, rotating, head movements, premium priced, rechargeable, pressure-sensor heads, brushing timer	Braun Oral-B Plaque Remover <sup>®</sup> , Interplak <sup>®</sup>
Third	Sonic, premium priced, rechargeable	Rowenta Dentasonic <sup>®</sup> , Sonicare <sup>®</sup>

**First generation:** The first generation of power toothbrushes had a head resembling manual toothbrushes, and moved back and forth to simulate manual brushing. The problems encountered with these products included short working time and mechanical breakdown. <sup>[1]</sup>

**Second generation:** The second generation had a uniquely rotating head and was powered by long-life/rechargeable batteries. It had increased efficacy compared to manual toothbrushes. The newer types incorporated the vibrating and reciprocal motion and additional features like pressure sensor and timer. <sup>[1]</sup>

**Third generation:** Sonic-powered toothbrushes and ultrasonic-powered toothbrushes were introduced. They were shown to remove more plaque in comparison to manual toothbrushes, especially in long-term studies. <sup>[1]</sup>

#### Sonic-powered toothbrush

It has a conventionally shaped head which vibrates in very high speed (>30,000

strokes per minute) in the audible range. This vibrating motion creates turbulent fluid dynamics that disrupts and removes dental plaque even beyond the point where the tips of the toothbrush's bristles actually touch. Most modern rechargeable electric toothbrushes from brands such as Sonicare<sup>®</sup>, FOREO<sup>®</sup>, and Oral-B<sup>®</sup> fall into this category and typically have a frequencies that range from 200 to 400 Hz, that is 12,000-24,000 oscillations or 24,000-48,000 movements per minute. Because sonic toothbrushes rely on sweeping motion alone to clean the teeth, the movement that they provide is often high in amplitude, meaning that the length of the sweeping movements that they make is large. <sup>[6]</sup>

#### Ultrasonic-powered toothbrush

It is the newest type of powered toothbrush which uses ultrasonic waves to clean the teeth. Ultrasonic toothbrushes emit vibrations that are very high in frequency (minimum frequency of 20,000 Hz) but low in amplitude. These vibrations break up bacterial chains that make up dental plaque and remove their methods of attachment to the tooth surface up to 5 mm below the gum line. Some ultrasonic toothbrushes, such as the Emmi-Dent<sup>®</sup>, provide only ultrasonic motion. Other ultrasonic toothbrushes, such as the Ultreo<sup>®</sup> and the Megasonex<sup>®</sup>, provide additional sonic vibration ranging from 9,000 to 40,000 movements per minute, comparable to a sonic toothbrush, in order to provide additional sweeping motion which facilitates removal of food particles and bacterial chain remnants. <sup>[1,6]</sup>

Certain toothbrushes that offer both ultrasonic and sonic motion allow for the intensity of the sonic motion to be reduced, or even for the sonic motion to be turned off entirely so that only ultrasound is emitted. Since ultrasound movements are very low in amplitude, this setting may be indicated for patients who may not be suitable candidates for typical sonic or power toothbrush vibration but need the additional cleaning power of an ultrasonic toothbrush, such as patients who have recently undergone periodontal surgery. <sup>[2]</sup>

When consumers first purchase the electric brush they tend to increase their frequency of brushing. The effectiveness is especially improved when the users are given instructions and controlled during the first 6-month period. With the development of the second and third generation of powered toothbrushes, it appears that long-term use is increasing. [7]

## CLASSIFICATION OF POWERED TOOTHBRUSH

### Mode of action

Powered toothbrushes are divided into six groups [8]

1. Side to side action- brush head moves laterally.
2. Counter oscillation- adjacent tufts of bristles (usually six to 10 in number) rotate in one direction and then the other, independently.
3. Rotation oscillation- brush head rotates in one direction and then the other.
4. Circular- brush head rotates in one direction.
5. Ultrasonic- bristles vibrate at ultrasonic frequencies (> 20 kHz).
6. Ionic- impart an electrical charge to the tooth surface with the intent of disrupting the attachment of dental plaque.

### Mechanism of action

The mechanism of action of powered toothbrushes can be categorised as mechanical, sonic or ionic.

The mechanical action powered toothbrush comes with rotating or oscillating heads. The heads are self-powered. As the bristles are pressed against teeth and gums, the rapid, constant movement removes plaque and food particles. [9] The efficacy of mechanical action powered toothbrush for the removal of plaque is superior when compared to manual toothbrushes. [10]

The sonic toothbrush has a rotating head and bristles. But in addition, it emits sound waves that create a vibration which helps in conjunction with the bristles to loosen plaque and food particles. The

efficacy of sonic technology in powered toothbrushes for the removal of plaque has not been substantiated by clinical data. [4]

Teeth naturally have a negative ionic charge and, conversely, food particles naturally have a positive ionic charge. These opposite charges are attracted to each other causing food particles to stick to the teeth. The ionic toothbrush temporarily changes the tooth's negative ionic charge to a positive charge. Then, another part of the toothbrush is positively charged, attracting the plaque and food particles away from the tooth. The bristles brush the loosened particles away. However, the effectiveness of this mechanism for the removal of plaque has not been substantiated by clinical data. [4]

## DESIGN AND ACTIONS OF POWERED TOOTHBRUSHES

The heads of most powered or mechanical toothbrushes are smaller than manual toothbrushes and are usually removable to allow for replacements. The head follows three basic patterns when the motor is started: (1) reciprocating, a back-and-forth movement; (2) arcuate, an up-and-down movement; and (3) elliptical, a combination of the reciprocating and arcuate motions. The bundles of bristles are arranged either in rows (as for a conventional toothbrush) or in a circular pattern mounted in a round head was more compact, single tufts which facilitate interproximal cleaning and brushing in less accessible areas of the mouth. All brushes rely primarily upon the abrasive, mechanical contact between the bristles and the tooth surface to effect cleaning. [8]

## OPTIONAL FEATURES OF POWERED TOOTHBRUSH [4]

A number of the new generation powered toothbrushes also incorporated design features which are aimed at improving the efficacy of cleaning and reducing the likelihood of toothbrush abrasion and gingival trauma in the long term. These features include:

### **Timer**

Many modern electric toothbrushes have a timer which buzzes, or briefly interrupts power, typically after two minutes, and sometimes every 30 seconds. This is associated with a customary recommendation to brush for two minutes, 30 seconds for each of the four quadrants of the mouth.

### **Display**

Some electric toothbrushes have LCD screens which show brushing time and sometimes smiley face icons or other images to encourage optimal brushing. These features could encourage people to brush more accurately.

### **Pressure sensor**

Brushing teeth too hard cause enamel and gum damage. Most modern top-end sonic toothbrushes come with a pressure sensor, which prevents users from brushing too aggressively. There are two types of pressure sensors. Some sensors produce a sound warning and some immediately stop movements of the sonic toothbrush when it is used too aggressively.

### **Ultrasound indicator**

Because of the fact that ultrasonic frequencies are beyond the audible range and the amplitude of movement emitted by an ultrasonic toothbrush is typically too small to be perceived, the ultrasound is imperceptible to humans and it may not be apparent that a brush running in pure ultrasound is turned on. Ultrasonic toothbrushes may include an indicator to notify the patient that ultrasound is being emitted.

### **Bluetooth**

Bluetooth connectivity enables data to be transmitted from an electric toothbrush to another Bluetooth device, such as a smart phone. The brush can send data to an app, such as how long it has been brushing for and if too much pressure has been applied when brushing. The app can in turn send data back to the brush such as changing the cleaning modes available, and cleaning time. The sharing of data between toothbrush and smart phone is intended to

assist the user in creating better brushing technique and habits. Electric toothbrush models that currently utilise Bluetooth include the Oral-B Pro 6000, Pro 6500, Pro 7000 and Genius 9000.

### **Cleaning modes**

Most sonic toothbrushes come with different cleaning modes and intensity levels. Cleaning modes are designed for special types of cleaning efficiency. Some of the most well known are Sensitive, Daily care, Whitening and Tongue cleaning.

## **RECOMMENDED POWERED TOOTHBRUSHING METHODS <sup>[11]</sup>**

Most powered toothbrush manufacturers do not recommend a specific brushing method; however, the electric brushes should be used in a specified manner. The Swiss Dental Society, in 2001 developed an instruction manual. Instructions for brushes with a sweeping and /or oscillating rotary motion are as follows:

- The brushes are positioned on the tooth surfaces in a 45- or 90-degree angle to the incisal plane.
- Only when positioned should the brush be switched to "on."
- The mouth should be almost closed.
- The brush should be moved slowly over and around each tooth for 3 to 5 seconds, making sure that the bristles clean the crevices between the teeth.
- The brush head can be lifted distally and mesially into the interproximal areas to reach the interdental area; the brush always remains on a single tooth.
- After a period of approximately 5 seconds, the brush is moved to the next tooth surface and repositioned.

Experienced individuals can use the brush also in a perpendicular angle to the teeth and gums, but the applied force has to be gentle. In this way, each tooth in the upper and lower arch is cleaned on the buccal and lingual surfaces. It is best to divide the mouth into four quadrants and start brushing on a tooth in the upper rear and then clean one surface after the other

very systematically. It is an easy way, gives good control for the individual, and does not omit any tooth surface. This method takes more time, because at a single time interval, only one tooth surface can be cleaned.

#### **INDICATIONS** [4]

- For orthodontic patients
- Those who are on supportive periodontal therapy
- Patients with prosthodontic or endosseous implants.
- For hospitalized patients
- Individuals with low manual dexterity, such as children and the handicapped

#### **CONTRAINDICATIONS** [4]

- Hypersensitivity- The vibration of powered toothbrushes can aggravate the sensitivity issues.
- Patients with cardiac pacemakers -As they can result in electrical interference with the normal functioning of implantable cardiac devices.

#### **ADVANTAGES** [2]

- Powered toothbrush increases patient motivation resulting in better patient compliance and increase accessibility in interproximal and lingual tooth surfaces.
- It uses less brushing force than manual toothbrushes.
- Brushing timer is incorporated in some brushes.

#### **DISADVANTAGES** [2]

- The cost and maintenance of powered brushes is more than manual toothbrushes.
- It also results in noise and discomfort due to vibration

#### **TRENDS IN POWERED TOOTHBRUSH**

Powered toothbrushes have undergone many technological advances in design and bristle motion, including rotation, oscillation and sonic vibration. Even though these products had been

available for many years, it was not until the 1990s that they became a common household item for dental hygiene self-care and a primary preventive tool. By 2001, powered toothbrushes accounted for 7% of all toothbrushes sold, compared to just 2% in 1999. In 1980s, battery-powered or disposable after "running down," powered toothbrushes were introduced. In most developed countries, the number of powered toothbrush products sold has increased dramatically in recent years. In Switzerland, the regular use of powered toothbrushes increased from 10 to 30% in the last decade. [4]

#### **POWERED TOOTHBRUSHES - INDIAN SCENARIO**

In India, a variety of powered toothbrushes are available which differ in their mechanism of action, mode and price range. Some of them have incorporated optional features like pressure-sensor and timer which makes them expensive. The leading brands in powered toothbrush category include Colgate, Oral-B, Philips, JSB, Trisa and Dento Shine. [12]

The different types of powered toothbrushes available under the Colgate brand include Colgate® 360° Charcoal Battery Operated Toothbrush, Colgate® 360° Total Advanced Floss Tip Battery-operated toothbrush and Colgate® 360° Surround Toothbrush with Vibrating Bristles. For the pediatric population, Colgate® Kids Spiderman Battery Operated Toothbrush and Colgate® Kids Barbie Battery Operated Toothbrush are available. All of them belong to second generation powered tooth brush with rotation oscillation action (ROA) except Colgate® 360° Surround Toothbrush with Vibrating Bristles which belongs to the third generation. [13]

Colgate® 360° Charcoal incorporates long, thin bristles infused with specially selected charcoal to provide better cleansing action and Colgate® 360° Total Advanced Floss Tip facilitates interdental cleaning with the help of floss tips. Colgate® 360° Surround Toothbrush with Vibrating

Bristles is a sonic tooth brush with a sonic cleaning power of 20000 strokes/ minute. [13]

Oral-B® brand offers a wide range of powered toothbrushes with cross action power. They include Oral-B® Pro 600 CrossAction Power Electric Rechargeable Toothbrush, Oral-B® Pro 2000 Cross Action Electric Rechargeable Toothbrush. Oral-B® CrossAction Power is a battery-powered toothbrush that uses a rotating PowerHead with CrissCross bristles for more cleaning action in every stroke than a regular manual toothbrush. It belong to second generation powered tooth brush with rotation oscillation action (ROA). [13]

Philips® brand provides a variety of sonic tooth brushes (third generation) which include Sonicare DiamondClean®, Sonicare Flex Care Platinum®, Sonicare EasyClean® for the adults and Sonicare For Kids® for the pediatric population. They incorporate additional features such as pressure sensor, timer and Bluetooth technology. [14]

### PRICE RANGE OF POWERED TOOTH BRUSH IN INDIAN MARKET (AS OF 2018) [12-14]

BRAND	PRICE RANGE (Indian Rupee, ₹)
<b>Colgate:</b>	
Colgate® 360° Charcoal	₹ 650-700
Colgate® 360° Total Advanced Floss Tip	₹ 600-650
Colgate® 360° Surround Toothbrush with Vibrating Bristles	₹750-850
Colgate® Kids Spiderman and Barbie	₹550-650
<b>Oral- B:</b>	
Oral-B® Pro 600 CrossAction	₹5800-6000
Oral-B® Pro 2000 CrossAction	₹3800-4000
<b>Philips:</b>	
DiamondClean®	₹11500-12000
Flex Care Platinum®	₹8500-9000
EasyClean®	₹4500-5000
Sonicare For Kids®	₹5500-6000

### MANUAL VERSUS POWERED TOOTHBRUSHES

Early commercially available powered toothbrushes lacked superiority compared with manual toothbrushes, and problems with mechanical breakdown caused their sales to decrease significantly. Despite this, dentists continued to recommend them for use in special

populations with diminished manual dexterity and cognition problems. [4]

### Safety

Powered toothbrushes are considered to be as safe as manual toothbrushes. They employ mechanical action instead of a manual action, reduces brushing force and the incidence of gingival bleeding because of gum damage. Powered toothbrushes are used with about one-third the force of manual toothbrushes. In epidemiological studies, it has been documented that populations are exhibiting increased gingival abrasion and recession. This has been associated with the increased use of oscillating powered toothbrushes. In comparison to these oscillating toothbrushes, sonic toothbrushes have been shown to do little harm to the gingiva. Also sonic brushes of this type can be used up to 6 or 12 months because the bristles show minimal overt signs of use and do not splay. [4]

Gingival abrasion is not influenced by brushing force, but is affected by the filament end-rounding of the brush. When compared to manual toothbrushes, powered toothbrushes do not cause greater gingival abrasion. [4]

### Effectiveness

Powered toothbrushes are as effective as traditional brushes. They not only move bristles at a much faster speed than the manual toothbrushes, but they also remove plaque more evenly in hard-to-reach places, such as inter proximal areas and on back molars. Powered brushes simulate the manual motion of toothbrushes with lateral and rotary movements of the brush head. Powered brushes with a rotation oscillation mode of action are more effective at reducing plaque and gingivitis when compared to manual brushes. No other powered brushes show consistent reductions in plaque and gingivitis in comparison with manual brushes. [15]

### CONCLUSION

Tooth brushing is generally accepted as the most efficient oral hygiene method of cleaning teeth. Powered toothbrushes have

been developed to improve and facilitate oral hygiene. Currently, various types of powered toothbrushes with different power supplies and different modes of action are available. Power toothbrushes are effective in removing plaque and reducing gingivitis. They are as safe as manual toothbrushes and have good compliance. Motivation to improve oral hygiene appears to be a key factor for patients to purchase powered toothbrushes.

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