

# Optimizing Beneficial Oral Hygiene Care: Transitioning from Manual Brushing and Utilizing Powered Toothbrushes to Improve Plaque Control and Prevent Gingival Inflammation

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May 2, 2022

## ABSTRACT

The main purpose of this research is to compare the effectiveness of powered and manual toothbrushes in controlling plaque and gingival inflammation, which are the common types of dental infections caused by lack of proper hygiene. Dental health and maintaining effective oral practices prove to be tantamount processes. To this effect, the underlying advantages and disadvantages of using either manual or electric toothbrushes in the removal of gingivitis and plaque is explicitly discussed. The paper provides an in-depth literature analysis and a review of previous articles that investigated the effectiveness of manual and powered toothbrushes. First, the literature analyzed terms such as gingivitis and host factors, the effect of manual dexterity, the effectiveness of manual and powered toothbrushes, and the safety of powered toothbrushes. Second, this paper adds to the existing research on this particular topic. Finally, the paper summaries the primary findings regarding the effectiveness and efficiency of using powered toothbrushes in the removal of plaque and minimizing gingivitis inflammation compared to utilizing manual toothbrushes. The research also concluded that individuals needed to maintain regular oral routines and brush for at least two minutes to achieve the desired results.

## INTRODUCTION

### 1.1 Background/ Context

Tooth brushing is a well-established health practice that aims to eliminate tooth plaques and preserve oral health. According to Davidovich, et al. (2020), self-reported oral hygiene behavior in Germany conformed to standard dental professional guidelines based on the frequency and length of routine teeth brushing. One possible explanation for the observed disparity between routinely conducted dental hygiene as well as the high incidence of periodontal disease is that individuals lack the necessary abilities to eliminate plaque. A recent series of investigations revealed that individuals brush their teeth frequently, however, they hardly succeeded in cleaning more than 30–40 percent of their gingival margins when using manual toothbrushes (Ying & Nicolau, 2021). This finding suggests that good manual tooth brushing is achievable, but individuals

may struggle to learn how to do it effectively. Compared to manual brushing, Vatsa, Choudhary, Kumar, & Priyadarshni (2021) suggested that dental experts or individuals who used electric toothbrushes achieved a better removal of gingivitis.

Philippe Guy Woog, a Swiss dentist, invented the first electric toothbrush in 1939 and dubbed it the brox-odent, which made cleaning teeth simpler (Adam, 2020). Since then, other innovators have continued to advance the innovation of the electric toothbrush to more efficient ones. The current electric toothbrush recommended by dentists is “Oral-B GENIUS X Electric Toothbrush”, which is rechargeable (Adam, 2020). Compared to the manual toothbrush, which makes 600 movements, the Oral-B GENIUS X Electric Toothbrush has rotating and oscillating bristles, which make 48,000 brush movements. Additionally, an increase in detrimental health effects resulting from using manual brushes has led to the replacement of electric toothbrushes (Otsuka et al., 2020). Electric brushes might significantly improve the brushing effectiveness of dental laypeople as compared to manual toothbrushes. This idea is confirmed by a recent meta-analysis conducted by Adam (2020), who found a slight but substantial benefit for electric toothbrushes over manual toothbrushes in terms of gingivitis and dental hygiene. The most modern toothbrush types include straighter, curved, angled, and contoured handles with grips and soft rubber regions to make them simpler to grasp and operate (Re, et al., 2015).

## 1.2 Problem of the statement

Dental health is important to individuals. Therefore, how to achieve good dental health depends on how a person brushes their teeth and the type of toothbrush used. To eliminate dental plaques and gingivitis, manual brushes may be used with force. Abrasion from tooth brushing is one component in the multifactorial process of dental health (Wiegand et al., 2013). Although teeth cleaning is thought to be insignificant in terms of abrasion of healthy dentin and enamel, it has been proven to be a substantial potential risk, mostly in the aetiology of erosive sores. Tooth brushing abrasion is governed by the abrasivity as well as the concentration of the toothpaste. Yet, it is influenced by the type of toothbrushes and scrubbing force, particularly on damaged dentin and enamel (Wiegand et al., 2013). There are several various electric toothbrushes and manufacturers available today. According to recent systematic research, electric toothbrushes do not have a clinically significant harm potential to hard and soft tissues compared to manual brushes (Ruiz Núñez, et al., 2021). Therefore, it is evident that electric brushes are gentler to the gums compared to manual ones, increasing one’s oral health.

According to Wiegand, et al. (2013), manual toothbrushes are usually used with greater brushing pressures than electronic toothbrushes, regardless of the brushing method. However, when compared to utilizing electric toothbrushes, using such greater brushing pressures resulted in increased abrasion of healthy and damaged dentin resulting in bleeding gums. Besides, Wiegand, et al. (2013) also noted that when using manual toothbrushes, there are un-brushed spots. These un-brushed spots may lead to bad breath. The same study states that manual toothbrushes are less effective and do not remove plaques and gingivitis both in the long and short-term brushing (Wiegand et al., 2013; Otsuka et al., 2020). Furthermore, the study states that manual toothbrushes are not ideal for the elderly due to dexterity problems. This is because the elderly may not have enough force to exert the brushing pressures required by the manual brushes to ensure dental hygiene (Wiegand, et al., 2013). Therefore, dental care is a core tenet of one’s overall health necessitating a high adoption and usage of electric brushes.

## 1.3. Significance of the study

The significance of this study is to understand the benefits linked to electric or powered toothbrushes and people’s oral health. Electric toothbrush usage helps eliminate dental problems, such as the build-up of dental plaque and gum inflammation. Gum Inflammation is caused mostly by dental plaque which can progress to periodontitis, a serious type of periodontal disease that affects 11% of the population of the world (Davidovich et al., 2020). Plaque accumulation can also cause caries (deterioration) in the adult dentition. Dental caries

is the most common illness globally, with a worldwide prevalence of 35% for all generations together. While the frequency of cavities has reduced in high-income nations over the last decades, it is growing in developing nations due to population increase, an aging population, different diets, and inadequate fluoride exposure. As a result, eliminating plaque and decreasing gingivitis play key roles in avoiding periodontal disease as well as tooth decay.

Electric toothbrushes have been recommended by dentists to eliminate plaques and gingivitis effectively (Elkerbout et al., 2020). Electric brushes function on the idea of micro acoustic streams whereby hydrodynamic force is created by the fast-vibrating bristles in a liquid media, assisting in the removal of plaques from the teeth (Ying & Nicolau, 2021). Initially, these brushes were meant to simulate back-and-forth scrubbing procedures that involved circular or elliptic movements. However, electric toothbrushes presently feature oscillating and spinning movements. Since the invention of the electric brush, the debate over whether it is more beneficial than a manual one in removing plaques and gingivitis still exists. Ying & Nicolau (2021) stated that electronic toothbrushes outperform manual toothbrushes in terms of plaque removal and periodontal health. Nevertheless, disadvantages exist of the electric brush over the manual.

Electric toothbrushes provide various significant dental health benefits, ranging from their user-friendly working design to changing brushing heads, depending on the brand manufacturer (Wang et al., 2020). Plaque easily develops in areas that toothbrush bristles cannot reach. Electric toothbrushes help to improve these residues, positively influencing dental or oral care by removing hard-to-reach plaque and protecting the gums. These brushes are further designed to function with braces or retainers and include built-in timers to guarantee safe and appropriate brushing to avoid gum recession from the tooth line (Kurtz et al., 2016). Therefore, this research explores the advantages of using electric toothbrushes over manual brushes.

## 2.0 REVIEW OF THE LITERATURE

### 2.1 Gingivitis and Host Factors

Pinto et al. (2013) studied the development of gingivitis in 12 healthy people with clinically normal gingiva by eliminating any assessment of oral hygiene. The authors found that lack of dental hygiene led to the development of marginal gingivitis in all individuals. Notably, the duration required for gingivitis to develop ranged from 10 to 21 days. However, dental hygiene re-introduced healthy gingival conditions, and the initial bacterial flora re-established. This critical study shows that gingivitis was caused by plaque formation and maturation and also that the participants varied in the speed at which gingivitis was formed. It also showed that adhering to normal teeth cleaning of practices in all participants reversed gingivitis in a short period. One of the health effects of gingivitis is that it causes increased vascular permeability and vasodilation. Besides, on probing, there seems to be an upsurge in bleeding. Rathee & Jain (2021) found inflammatory cells in gingival tissue whenever there is bleeding. Other participants in the study demonstrated that the predictive accuracy of bleeding after close examination for periodontitis development was only 6 percent. In contrast, the negative predictive value was 98 percent, making persistent lack of bleeding a credible indicator of periodontal health maintenance.

### 2.2 The Effects of Manual Dexterity

Additionally, Goh & Lim (2017) published the results of crossover research on differently-abled individuals to assess plaque removal in manual and electric or powered teeth brushing. Participants observed the manufacturer's instructions and then were permitted to use the toothbrushes for eight days on receiving them. The state of the eighth-day plaque was evaluated pre and post-brushing. On the planned day of evaluation, respondents were asked to refrain from doing oral hygiene activities for 6 hours. There was no notable change in plaque removal effectiveness between electric and manual brushes in a given cleaning among differently-abled participants. Still, they found a substantial drop in post-brushing values compared to pre-brushing

levels for the different toothbrush types. Baruah et al. (2017) also documented 6-month results for mentally disabled persons using manual brushes enhanced with sound directions, observing that certain training led to a proportional decrease in plaques and gingival score to the usage of electric brushes. Repeated trips and continual support from caregivers may be key factors for greater compliance to enhance dental hygiene. Besides, various ailments and circumstances, like arthritis, pregnancies, mentally unstable, and mentally disabled people, imply that different people may react differently to challenging oral hygiene procedures.

## 2.3 Manual toothbrushes

Manual toothbrushes are manufactured by particular brands and offered in various designs which are intended to guarantee the competence for plaque control or removal. Unfortunately, no manual toothbrush type was superior to another until 1998 (European workshop on mechanical plaque control). In the modern-day, transverse action models have shown greater plaque reduction levels. Elkerbout et al. (2020) published the results of two single-use tests assessing the Colgate Precision, Oral-B P35, and Crest Complete brushes. Plaque was detected after the use of these designs, and there were no substantial variations between the brushes. Re et al. (2015) discovered that the Colgate Precision, as well as three additional brushes, were less successful than Oral-B Advantage Plaque Remover in removing plaque and reducing gingivitis in the whole mouth.

Erbe et al. (2019) discovered that using a twin-headed toothbrush can help with plaque reduction, particularly lingual in the molar regions, where even the tongue can sometimes "protect" the gingival edges. Plaque located in these areas is more impossible to recognize and access than that on buccal surfaces and front teeth. Erbe et al. (2019) contrasted a double-headed toothbrush to a standard flat trim brush (Oral-B 32) in 44 individuals for one week. The research found out that this new design was substantially more successful in total plaque removal. This impact was most noticeable on all linguistic regions, particularly the bottom arch and molar areas. Moreover, Marcia Delaurenti et al. (2017) evaluated a novel triple-headed brush type that promised to remove plaque on lingual, buccal, and molar areas simultaneously. The toothbrush was contrasted to a conventional flat-headed brush (Oral-B P35) following the criteria for evaluating chemotherapeutic drugs, which call for a six-month assessment for long-term gingivitis and plaque reduction. Throughout the six-month study, the sample population eliminated substantially higher plaque amounts, including lingual and buccal, than the flat-headed brush that removed just a considerable quantity of buccal plaque. In 6 months, the triple-headed toothbrush was considerably superior to the flat-headed toothbrushes at reducing gingivitis in the linguistic regions.

Building on this, Xu et al., (2019) toothbrush usage research comparing flat-trim and crisscross brushes found extremely substantial plaque elimination from baseline with certain manual toothbrush types (Crisscross and regular bristle styles). Considerable plaque elimination was observed not only across the mouth (at about 84 percent), as well as in interproximal regions (95 percent). The discovery that cross-action toothbrushes were reliably and considerably better than regular ones at removing plaque as per the Rustogi Modified Navy Plaque Index was of particular interest (Xu et al., 2019). The study focused on the direct relevance for distinguishing between toothbrushes in terms of plaque removal efficacy. A variety of design factors may distinguish commercially available toothbrushes. Still, the bristle arrangement, especially Criss-Cross bristles oriented in opposite directions, is the dominant attribute of the three brushes that demonstrated effectiveness in the study (Xu et al., 2019). These findings confirm the notion that the primary weakness of traditional flat-trim brushes is related to the inhibitory effect of constricted bristle tufts that restrict separate tufts from accessing interproximal regions. New toothbrushes include different filament designs meant to improve plaque elimination from difficult-to-reach places (Xu et al., 2019). When compared to flat-trim toothbrushes, angled or multilevel brush designs remove more plaque.

## 2.4 Powered toothbrushes

The usage of powered or electric toothbrushes compared to manual toothbrushes in terms of their capacity to eliminate plaque and enhance gingival hygiene is becoming an area of study. Drawing from Kurtz et al. (2016), their study placed a manual toothbrush and two electric brushes of different manufactures (D3 and Braun D5) on testing for two minutes. Although expert instructions were presented to the participants, the findings of this investigation showed that electric toothbrushes were much more useful in removing plaque than manual brushes. Furthermore, the notable difference seen between manual brush as well as the D5 was only 4 to 6 percent, but the effectiveness of interproximal advantage was 12 percent. The researchers thought the change had a clinically meaningful effect. Davidovich et al.'s (2020) comprehensive review also found that electric toothbrush users had greater efficacy in reducing gingival bleeding or inflammation than manual brush users in 10 trials. This impact appears to be connected to plaque removal capabilities and became more noticeable in O-R and reverse rotating electric toothbrushes.

Further, Adam et al. (2020) conducted a randomized review on 51 trials. They discovered that they did not perform prophylaxis at the start resulting in the real decrease of MGI (Modified Gingival Index) observed an 11 percent drop in plaque for Quigley & Hein index in the short run and a 21 percent reduction in the long run. In terms of gingivitis, there is intermediate quality evidence that power toothbrushes reduce gingivitis by 6 and 11 percent, correspondingly, according to the Loe & Stillness index (Adam et al., 2020). Plaque and gingivitis were reduced using O-R power toothbrushes in a statistically meaningful way. Using an experimental design, Atrushkevitch et al. (2018) also evaluated the effectiveness of electric toothbrushes. A power brushing activity reduces plaque scores by 46 percent on average with a span of 35-67 percent depending on the index scale used to assess plaque. The power source (battery-powered), mechanisms of action, scrubbing length, and kind of directions are all elements or brushing-related factors that influence the reported effectiveness.

Ikawa et al. (2021) went on to investigate the effectiveness of powered brushes over six weeks. In this particular study, the Philips/Jordan HP 735 electric toothbrush, the Braun/Oral B D7 electric toothbrush, and the Oral B Advantage B35 manual flat-trim toothbrush were issued to a group of 75 youngsters. The study found that power brushes are much more effective than manual toothbrushes in removing plaque, though substantial improvement was still seen at interproximal areas (Ikawa et al., 2021). The overall plaque removal performance of the Philips/Jordan HP 735 as well as the Braun/Oral B D7 was nearly comparable. However, the HP 735 generated lower GI ratings than the D7 in six weeks. Nevertheless, interpreting the longitudinal improvements in GI should be made carefully since no information was collected at screening. A potential Hawthorne effect might well have impacted the research (Ikawa et al. 2021). In addition, manual brushes had substantially higher teeth scrubbing forces than power brushes. Even the clicking threshold technique on the HP 735 decreased the variance in tooth brushing force that was noticed whenever the toothbrush was initially used.

In a split-mouth approach, Singh et al. (2011) examined Braun and Sonicare's toothbrush usage effectiveness to manage plaque and decrease induced gingivitis. Two weeks just before the onset of experimental gingivitis, respondents were given toothbrushes with expert directions. When compared to the Sonicare toothbrush, the Braun reduced bleeding more quickly and effectively (Singh et al., 2011). At four weeks, there was no significant change in plaque index across the three classes of participants. According to Singh et al.'s (2011) conclusions, the action and design of the Braun electric toothbrush were more successful than Sonicare toothbrush in the healing of gingivitis. Also, Dhir & Kumar (2018) published the results of 18-week research in which individuals used either a Philips/Jordan HP 735 electric brush or a manual brush (Oral-B). Following each examination, both participants had 3 minutes of monitored brushing. In a sample of inexperienced participants with electric toothbrushes, the plaque index (PI) and gingival bleeding index (GBI) were measured and revealed that the electric toothbrush was substantially more effective in eliminating plaque and enhancing gingival health than that of the manual toothbrush. There was also a substantial learning impact with the electric toothbrush, which was more evident.

## 2.5 Safety of Powered Toothbrushes Usage

Rosema et al. (2014) researched to determine the prevalence of gingival abrasion as an outcome of teeth cleaning with a manual toothbrush and the Braun electric toothbrush. According to the findings of this study, both the electric toothbrush as well as the manual brush induce mild periodontal abrasion as a reaction to the scrubbing of teeth. Kamreddy (2019) also looked at gingival inflammation. They discovered that both the manual and electric brushing groups showed no substantial improvements in gingival inflammation throughout the one-year research. Besides, Grender et al. (2020) conducted a systematic study to evaluate the risk of electric brushes. Twenty-four trials that looked at health as a secondary objective found few brushing-related side effects. The average score in the two trials was 0.03 (Grender et al., 2020). This systematic analysis of a vast body of recorded literature from the last two decades repeatedly demonstrated that O-R electric brushes are harmless compared to manual brushes and do not represent a clinically significant risk to either soft or hard parts. Gallob et al. (2016) further studied the development of regression in healthy participants with pre-existing regression who cleaned their teeth twice daily for two minutes either with a powered or manual toothbrush. The average gingival recession did not vary substantially among the sets after three years. However, the pre-existing regression considerably decreased after three years of tooth cleaning with a powered toothbrush versus a manual brush.

## 2.6 Brushing duration

Rosema et al. (2014) aimed to assess the PI (Plaque Index) following brushing with a manual, blendadent, and an electric brush (Braun) for a particular amount of time ranging from 7.5 seconds per quadrant to 90 seconds per quadrant of expert teeth cleaning. Besides, a dental assistant did brushing for all individuals in the research. Braun (Powered) toothbrush was much more efficient from 15 to 90 seconds. It outperformed the Manual and Blendadent brushes by a wide margin. Analysis of effectiveness regarding brushing duration revealed that the majority of the impact is achieved after 30 seconds of brushing each quadrant for all toothbrushes. Brushing duration proves to be an important factor in determining plaque removal efficacy (Erbe et al., 2018; Baruah et al., 2017). These findings are similar to the second research comparing the same electric toothbrush to a manual toothbrush, in which volunteers were asked to clean their teeth in their normal ways. Still, they were secretly monitored and evaluated for residual plaque amounts by using the Turesky Plaque scale. The findings revealed a general negative association between PI and brushing duration. The authors found that the R-O electric toothbrush offered clinical improvements in plaque and calculus reduction compared to a manual toothbrush, even in participants who had had no prior oral hygiene education. Brushing durations varied greatly, ranging between 28 and 270 seconds (Rosema et al., 2014). Nevertheless, 50 of the 76 electric toothbrush users spent approximately 2 minutes using the brush. In comparison, just 14 of 81 patients who used a manual brush spent two minutes or longer brushing.

## 2.6 Replacement and deterioration

The effectiveness of plaque elimination is affected by toothbrush bristle wear, as well as how long a brush is used (Rosema et al., 2014). The degree of toothbrush deterioration, like the quantity and level of matting and tapering, may be connected to the toothbrush's ability to remove plaque. To this effect, George & John (2016) investigated the effect of progressive brush use on plaque management. Each of the 20 individuals was offered a new toothbrush at the commencement of the test, which they used during the duration of the nine-week research. All plaques were properly cleaned at weeks 0, 3, and 6, as well as the quantity of plaque formed in each subsequent 3-week period of the experiment, was evaluated at weeks 3, 6, and 9 (George & John, 2016). Toothbrush wearing was measured by visual inspection of tracings of scrubbing area patterns acquired from standardized photos. Despite increased toothbrush usage, the quantity of plaque formed in each subsequent 3-week period was considerably reduced. Toothbrush wearing varied substantially across individuals, however, there were no significant variations in plaque ratings between participants having toothbrushes with most and least wearing (George & John, 2016). Atrushkevitch et al's (2018) research also concluded that there was no clinically noticeable difference in plaque scores decrease after a 2-minute brushing activity between 3

months period when using manual toothbrush and new manual toothbrushes. Nevertheless, rather than just the age of the toothbrushes, the wear rate of the bristles appeared to have been the decisive factor in the decrease of effectiveness. Lastly, Harvey et al. (2015) examined plaque removal efficiency after individuals brushed for 2 minutes either with a brand-new toothbrush or an old toothbrush they had been using for three months and afterward, re-scored the plaque. R-O Electric brushes with three-month bristles with various extents of wear outperformed new toothbrush bristles in plaque removal. Harvey et al (2015) found that bristle aging and wearing of an electric toothbrush did not impair plaque removal efficacy.

### 3.0 CONCLUSION

Both manual and electric toothbrushes are vital to maintaining a person's dental health. One of the health effects of gingivitis is that it causes increased vascular permeability and vasodilation. Adhering to normal teeth cleaning practices when using manual or electric toothbrushes can reverse gingivitis in a short period. However, the average brushing time for effective removal of plaque and gingivitis by using either of these toothbrushes is 2 minutes. Based on this study, it is evident that powered brushes achieve a moderate reduction of plaque and gingival bleeding scores compared to manual brushes which require more brushing force. Thus, patients with severe tooth wear and exposed and eroded dentin surfaces should use electric toothbrushes to reduce abrasion. Individuals who prefer to use a powered brush can be assured that in general there is not much difference between powered and manual brushes. Manual brushes are still a choice for routine use for many people around the world. Nevertheless, powered brushes are considered safe despite their high prices.

Of interest is that individuals brush their teeth for a variety of reasons, including feeling refreshed and confident, eliminating mouth odor, and preventing the occurrence of infections. To this effect, a person's choice to use a particular toothbrush, either manual or powered, produces similar results. Electric toothbrushes might be appealing to certain people since they offer a 'high tech' approach compared to manual ones. These toothbrushes tend to eliminate build-ups of gingivitis and plaque significantly than manual toothbrushes, both in the long-term and short-term. Further, the rotating oscillation of electric brushes demonstrates effectiveness in gingivitis and plaque removal. The efficacy of rotating oscillation brushes is also considered vital in the prevention and treatment of periodontal disease. Plaque, cigarette usage, and specific medical conditions are all linked to the development of periodontitis. Both periodontitis and gingivitis increase a person's susceptibility to gum-related inflammatory issues, bleeding, and destruction of the bacterial flora composition.

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