Review Article

Uses and Applications of the Manual Versus Electronic Toothbrush: A Literature Review

Sofía Castro[1], Sedany Garay[1], Fran Espinoza-Carhuancho[2], Daniel Alvitez-Temoche[3], Arnaldo Munive-Degregori[4], John Barja-Ore[5], Frank Mayta-Tovalino[1]

[1]Academic Department, Faculty of Dentistry, Universidad Nacional Federico Villareal, [2]Grupo de Bibliometria, Evaluacion de evidencia y Revisiones Sistematicas (BEERS), Human Medicine Career, Universidad Cientifica del Sur, [3]Vicerrectorado de Investigación, Universidad Nacional Federico Villarreal, [4]Academic Department, Universidad Nacional Mayor de San Marcos, [5]Department of Research, Universidad Privada del Norte, Lima, Peru

Abstract

Aim: The aim of this study was to describe the scientific literature on the use and applications of manual and electronic toothbrushes. **Materials and Methods:** An electronic search without date restriction was carried out in the PubMed and Scopus databases. The articles were selected, and their characteristics, objectives, and methods were analyzed using the following keywords: "manual toothbrush," "electronic toothbrush," "interdental brush," "dental plaque," "gingivitis," "periodontitis" and "mechanical cleaning." Ten relevant studies investigating the uses and applications of manual versus electronic toothbrushes were selected for this review. **Results:** The studies determined the efficacy of electronic and manual toothbrushes for the reduction of gingivitis and plaque, detailing the characteristics of the populations. Some studies evaluated the effectiveness of the two classes of brushes using different dental plaque indexes. One study determined plaque removal by comparing an interactive versus manual toothbrush, and two studies evaluated the effectiveness of the brushes in plaque reduction in a pediatric population. Based on the research articles, it was evident that some studies found no significant difference in biofilm removal in the use of electronic toothbrushes versus manual toothbrushes. **Conclusion:** In summary, it is not possible to give a conclusion because there is a discrepancy between the authors, and further studies are needed to corroborate and contrast the usefulness of manual and electronic toothbrushes.

Keywords: Biofilm, Electronic Toothbrush, Plaque Index, Review

Received: 26-Jun-2023, **Revised:** 21-Oct-2023, **Accepted:** 21-Oct-2023, **Published:** 29-Dec-2023.

Introduction

It has been shown that natural methods of oral hygiene do not significantly affect the formation of dental plaque. Therefore, toothbrushing is a mechanical procedure to remove bacterial plaque and achieve dental health without the risk of pathological diseases.[1] At present, there is a wide range of toothbrush varieties available in the market, chosen according to the operator's taste, efficacy, and eco-friendliness, among others. They can be divided into two main groups, manual and electronic toothbrushes.[2]

At present, there are many brushes developed with innovative technology where great importance is placed on the design of the bristles in manual and electronic devices. The conical bristles known for having ultra-thin bristles reach better the proximal areas and the molars that are distal to the midline.[3]

It is well known that toothbrushing without oral hygiene adjuncts such as flossing will not have a significant effect on plaque removal. So, if these measures are not taken, it can lead to gingivitis, and if not treated in time and with continuous hygiene it can develop into periodontitis. Therefore, it is important to emphasize the effectiveness of mechanical biofilm control devices in keeping oral hygiene by removing plaque.[4]

Address for correspondence: Dr. Frank Mayta-Tovalino, Postgraduate Department, Universidad Nacional Federico Villarreal, Calle San Marcos 351, Pueblo Libre 15084, Lima, Peru.
E-mail: fmayta@unfv.edu.pe

Access this article online

Quick Response Code:

Website: www.jioh.org

DOI: 10.4103/jioh.jioh_149_23

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Castro S, Garay, Espinoza-Carhuancho F, Alvitez-Temoche D, Munive-Degregori A, Barja-Ore J. Uses and applications of the manual versus electronic toothbrush: A literature review. J Int Oral Health 2023;15:500-8.

Effective cleaning by using a conventional toothbrush will depend on the knowledge about the execution of suitable movements in the oral cavity and thus avoid the appearance or spread of caries. On the other hand, electric toothbrushes are highly effective and innovative. Because of this, it is very helpful for certain patients who lack motor skills such as people with some kind of physical disability.[5]

The basic principle of electric toothbrushes is acoustic microflow, where the rapid vibration of the bristles generates hydrodynamic forces in the liquid medium, effectively eliminating the colonization of microorganisms on the tooth surface.[6] Over the years, electric toothbrushes have gained wider popularity among the general public, leading to an increased need for clinical evidence to determine the most suitable type of toothbrush for better plaque control and improved oral health. Furthermore, there is a significant variation in prices and brands of these products in the market, which depends on the individual's needs and diagnosed oral conditions.[7-9]

Thus, the purpose of this literature review was to describe and differentiate the uses and applications of manual and electronic toothbrushes.

Materials and Methods

Study design

The study design was a literature review and therefore it was not necessary to register in Prospero.

Inclusion criteria

Randomized controlled trial articles on manual and electronic toothbrushing were preferentially sought in this article. Only articles considering the characteristics, advantages, and disadvantages of both types of brushes were included. The search was limited to research articles published in the English language.

Exclusion criteria

Systematic and clinical case reviews on brushing types were not included in the present research. Likewise, articles not found in PubMed and in any language other than English were excluded.

Search strategy

For the recognition of the studies, a digital information search was performed without date restriction in the online database for research literature search in biomedical and biological sciences such as PubMed and Scopus. The following search strategy was designed and adapted according to each database: ("Toothbrushings"[Title/Abstract] OR "Toothbrushing"[Title/Abstract] OR "Toothbrush"[Title/Abstract] OR "Manual Toothbrush"[Title/Abstract] OR "Powered Toothbrush"[Title/Abstract]) AND ("Dental Plaque"[Title/Abstract] OR "Plaque Dental"[Title/Abstract] OR "Dental Plaque Index"[Title/Abstract] OR "Indexes Dental Plaque"[Title/Abstract] OR "Indices Dental Plaque"[Title/Abstract] OR "Dental Plaque Indexes"[Title/Abstract] OR "Dental Plaque Indices"[Title/Abstract] OR "Index Dental Plaque"[Title/Abstract]).

Risk of bias

Because it is a literature review it is exempt from risk of bias assessment of the content of the manuscripts evaluated.

Results

Relevant studies related to the comparison between manual and electronic toothbrushing were found in the searches performed. Ten studies investigating the comparison of manual and electronic toothbrushing efficacy were considered for the present review. Details of the reviewed studies are shown according to their objective, population, study method, and conclusion [Table 1].

Dental plaque

Bacterial plaque is characterized as intricate, sessile communities of microorganisms that form on the tooth surface and are enveloped within an extracellular matrix consisting of polymers from both microbial and host origins. Moreover, biofilms play a role in the development of various chronic diseases.[10] Plaque typically accumulates in natural retention areas, such as gingival margins, and dental defects. However, these retentive surfaces within the mouth can be effectively cleansed and protected using electric toothbrushes, which have shown superior plaque reduction capabilities.[4]

Gingivitis

The natural accumulation of supragingival biofilm on tooth surfaces is closely linked to gingival inflammation and the onset of common oral diseases.[11] Clinically it is characterized by redness in the gums and absence of periodontal attachment loss.[12] It is usually painless; therefore, it is unlikely to be noticed by the operator during the development of the disease. Incorrect methods used during dental hygiene will be the reason for the development of gingival disease, in turn, it favors a greater increase of biofilm to fixed prostheses with poorly accommodated and subgingivally placed margins causing the initial development of gingivitis.[13]

Periodontitis

Periodontitis is a chronic inflammatory condition characterized by the gradual degradation of the periodontium, specifically the alveolar bone and periodontal ligament.[14] The presence of subgingival biofilm is the primary local factor responsible for the initiation and advancement of periodontal disease.[15]

Table 1: Characteristics of the studies

Author/year	Aim	Population	Method	Conclusions	Experimental group	Control group	Follow-up/ methodological design
A Ramseier *et al.* 2021[43]	To evaluate oral fluid biomarkers among individuals with gingivitis, a study was conducted over an 8-week period.	The participants had an average age of 23 years, and 52% of them were female. They were randomly assigned to two groups, each consisting of n = 30.	Both groups performed tooth brushing twice daily at home. Measurements of the gingival index, gingival crevicular fluid were collected at weeks 2, 4, and 8.	The findings indicate that subjects using a combination of an electric toothbrush and irrigator showed improved clinical outcomes, accompanied by similar trends of improvement in oral fluid biomarkers such as IL-1β.	Electronic toothbrush center (Oral-B professional care oxyjet 1000 with Oral B precision clean brush head EB20)	Manual toothbrush (Oral B indicator 35 soft)	Randomized controlled clinical trial (8 weeks)
Ccahuana-Vasquez *et al.* 2019[26]	To assess the effectiveness of a rechargeable oscillating-rotating (OR) electric toothbrush, in reducing biofilm compared to a manual toothbrush.	A total of one hundred and fifty subjects were randomly assigned to either the Oral-B Vitality OR (D12) handle nd novel Oral-B sensitive brush head (EB60). This 5-week study was conducted in a randomized, examiner-blinded, parallel-group design.	Randomized, examiner-blinded, parallel-group, 5-week study.	The results showed that the combination of the surgical handle and the round brush head with tapered bristles achieved significantly greater reductions in biofilm and gingivitis compared to the manual toothbrush.	The Oral-B Vitality D12 with a rechargeable electric toothbrush handle that comes with a rounded brush head (OH, USA). The brush head features standard filaments rounded in the center. Surrounding it is an outer ring of tapered bristles. These bristles have a standard diameter at their base and gradually taper to a fine tip diameter of 0.01 mm.	An ADA manual toothbrush (American Dental Association, Chicago, IL, USA) with end-rounded bristles	randomized, two-treatment, examiner-blind, parallel group study (5 week)
Davidovich *et al.* 2021[44]	To compare the efficacy of manual toothbrush and oscillating-rotating electric toothbrush versus in reducing biofilm in a children with primary and mixed dentition.	Forty-one children, comprising 20 children aged 3 to 6 years and 21 children aged 7 to 9 years, participated in the study. They were assigned to a treatment sequence that included the use of an Oral-B Kids electric toothbrush and a manual toothbrush as a control.	The study followed a randomized crossover design with a single brushing session, involving two treatments and four periods of repeated use.	In children aged 3 to 6 years with deciduous dentition, the electric toothbrush showed a 32.3% greater reduction in plaque compared to the manual toothbrush ($p = 0.005$). Similarly, in children aged 7 to 9 years with mixed dentition, the electric toothbrush showed a 51.9% greater reduction in plaque compared to the manual toothbrush.	Oral-B Kids oscillating-rotating electric toothbrush (D100 kids handle with EB10 brush head; Procter & Gamble, Cincinnati, OH, United States),	Manual brush group were given a Paro Junior Soft (#742, Esro AG, 8802 Kilchberg, Switzerland)	This randomised, single-brushing, examiner-blind, 2-treatment, 4-period, replicate-use crossover study.

Table 1: Continued

Author/year	Aim	Population	Method	Conclusions	Experimental group	Control group	Follow-up/ methodological design
Ghassemi *et al.* 2013[45]	To determine the biofilm removal efficiency of an electronic toothbrush for children and compare it to that of a manual toothbrush.	A total of 105 qualified male and female subjects participated in the study, with 52 individuals aged 8 to 12 years and 53 individuals aged 13 to 17 years.	They were randomly assigned to either an electric toothbrush (Spinbrush GLOBRUSH) or a manual toothbrush (Oral-B Indicator 30 Compact Soft Toothbrush).	The results showed that the GLOBRUSH Spinbrush showed significantly higher efficiency in reducing biofilm compared to the manual toothbrush.	Spinbrush GLOBRUSH, Arm & Hammer Co, Inc. Princeton, NJ, USA	Manual toothbrush Oral B indicator 30 Compact soft toothbrush, Procter & Gamble OH, USA	Blind randomized cross-over study (One week)
Nightingale *et al.* 2014[46]	To assess the effectiveness of a sonic toothbrush in reducing biofilm and maintaining gingival health compared to a manual toothbrush.	A total of 84 subjects were evaluated in the study and randomly assigned to receive either the sonic toothbrush or a standard manual toothbrush that had been approved by the American Dental Association.	The subjects were provided with instructions to adhere to a brushing regimen twice a day, without incorporating flossing into their oral hygiene routine.	The results revealed that the American Dental Association-approved manual toothbrush showed a significantly higher ability to safely remove biofilm compared to the standard manual toothbrush.	Pana-sonic EW-DL90 (Panasonic Corporation of North America,Secaucus, NJ, USA)	Manual group received anAmerican Dental Association (ADA)-approved manual tooth-brush (Pepsodent Complete Care toothbrush; Unilever, Engle-wood Cliffs, NJ, USA	Block-randomized, examiner-blind, two-treatment, parallel group (3 week)
Vorwerk *et al.* 2016[47]	To evaluate the effectiveness of a new motorized toothbrush compared to a manual toothbrush in removing microorganisms.	A total of sixty-two qualified subjects participated in the study and were randomly assigned to both groups.	To assess microorganism removal, subjects were instructed to abstain from oral hygiene for 12-16 hours and from eating and drinking for four hours.	The results showed that the electric toothbrush was statistically significantly more effective in reducing plaque compared to the manual toothbrush.	Arm & Hammer Spinbrush Truly Radiant Clean & Fresh Battery-Powered Toothbrush	ADA Standard Manual Toothbrush	Randomized, examiner-blind, cross-over clinical trial
Kulkarni *et al.* 2017[5]	To assess the effectiveness of the Oral-B electronic toothbrush and the Oral-B40 manual toothbrush in reducing supragingival plaque.	Forty-five patients aged 19 to 23 years were enrolled in the study.	The data collected from the study were carefully analyzed, and various subgroups were compared to evaluate and compare their effectiveness.	The results showed that individuals who used the electronic toothbrush achieved significantly better results in terms of supragingival plaque reduction compared to those who used the Oral-B40 manual toothbrush.	Powered toothbrush (Braun/ Oral-B two-dimensional)	Manual toothbrush (Oral-B40 Regular Advantage Plus)	Randomized clinical trial (4 weeks)

Table 1: Continued

Author/year	Aim	Population	Method	Conclusions	Experimental group	Control group	Follow-up/ methodological design
Conn *et al.* 2017[48]	The purpose of this study was to compare the bacterial biofilm reduction ability of two manual toothbrushes: a novel toothbrush design and a control reference brush.	A total of thirty-eight individuals agreed to participate in the study and received both brushes eight days before data collection.	To assess the biofilm reduction, baseline plaque scores were recorded before the brushing session. After brushing, post-brushing plaque scoring was conducted.	The results revealed that the novel toothbrush design outperformed the control reference brush in terms of biofilm removal, particularly on the lingual and lower jaw surfaces. The concerning brush showed suboptimal performance in biofilm removal compared to the new design.	Novel brush (MD)	Reference toothbrush (ADA)	Pilot Study
Erbe *et al.* 2019[49]	The objective of this study was to compare the effectiveness of a manual toothbrush versus an interactive toothbrush in achieving adequate plaque removal in orthodontic patients.	A total of sixty adolescents with fixed orthodontic appliances in both arches participated in the study.	Plaque removal was assessed using the modified Quigley-Hein Index by Turesky, measuring the change from baseline at 2 and 6 weeks. The results indicated that the interactive electric toothbrush generated longer brushing times and significantly greater biofilm removal compared to the manual toothbrush.	This suggests that the use of an interactive electric toothbrush can be more effective in achieving adequate plaque removal in orthodontic patients when compared to a manual toothbrush.	Interactive power toothbrush (Oral-B Professional Care 6000, D36/EB20) with Bluetooth technology	Regular manual toothbrush (Oral-B Indicator 35 soft).	Parallel, randomized, examiner-blind controlled clinical trial (6 weeks)
Khan *et al.*2022[17]	To assess and compare the effectiveness of a manual toothbrush and an electronic toothbrush in reducing biofilm and gingival disease.	A total of fifty-six subjects were randomly divided into two groups, with 28 subjects in each group.	Biofilm reduction was assessed using a disclosing agent in the form of a two-tone solution, which allowed for the detection of plaque. The Loe and Silness gingival index was used to evaluate gingival scores, providing a measure of gingival disease assessment..	The findings of the study indicated that the electronic toothbrush had additional advantages in improving oral hygiene compared to the manual toothbrush. This suggests that the electronic toothbrush may be more effective in reducing biofilm and addressing gingival disease when compared to the manual toothbrush.	Powered toothbrushes	Both manual	Randomized clinical study (6 weeks)

Mechanical cleaning

The regular mechanical removal of biofilm does not pose a risk of opportunistic infection; instead, it alters the composition of the biofilm. Patients who show optimal oral health conditions typically have a significant presence of *S. mitis* or *S. sanguis,* which are beneficial bacteria, in their dental biofilm, whereas the percentage of cariogenic bacteria is minimal.[16] Therefore, manual, and electric toothbrushing, as effective mechanical cleaning methods, are instrumental in controlling and preventing the proliferation of bacterial plaque. However, it is important to note that without additional oral hygiene practices such as rinsing, flossing, and using a tongue cleaner, the average individual can only effectively remove biofilm.[17]

Manual toothbrush

The manual toothbrush remains a widely used method for controlling bacterial plaque, cleaning teeth, and promoting healthy gums in present times.[18] However, being a manual tool, it lacks the ability to provide precise timing guidance for each side of the dental arch. Consequently, it may not effectively achieve plaque-free tooth surfaces, particularly in the interdental, molar, and lingual regions.[19,20]

Electric toothbrush

Electric toothbrushes were introduced to the commercial market in the 1950s.[21] Over time, various innovations have been developed to enhance the user's ability to achieve optimal daily oral hygiene, including adjustments in brushing frequency and amplitude.[22] The design of electric toothbrushes aims to replicate the back-and-forth motion of different brushing techniques. Early electric toothbrushes were designed to perform circular movements, but more recent models feature rotating and oscillating movements.[23] Studies have shown that electric toothbrushes, on average, reduce bacterial plaque by 46%. Rechargeable electric toothbrushes with oscillating rotation tend to offer greater advantages compared to those with replaceable batteries.[24]

Efficiency between electric and manual toothbrushes

The effectiveness of tooth cleaning using a manual toothbrush depends on the user's skill, the time devoted to brushing, and the brushing technique employed.[25] In a specific study, both electric and manual toothbrushing were found to reduce the plaque index, leading to improved gingival health. However, the use of an electric toothbrush showed a greater decrease in the plaque index and greater improvement in gingival health,[5] as shown in Table 1 of the reviewed study. Moreover, Oral-B has consistently enhanced and refined their electronic toothbrushes, incorporating features such as a higher number of oscillations, an ergonomic handle, and pressure sensors to enhance tooth cleaning efficiency, particularly in hard-to-reach areas.[26]

Toothbrushing recommendations

In general, it is advised to brush twice a day with a dentifrice that includes fluoride for 2 minutes to prevent the spread of plaque, and counteract the accumulation of caries and gingivitis.[27] However, no set brushing time should be taken as each patient's need is unique, for example, the patient's anatomical conditions and motor skills. In other words, brushing time varies in patients who present diseases that delay the average cleaning time as in geriatric patients.[28] Similarly, it is essential to have advice from a dental professional on oral care and hygiene and for the patient to be aware of preventive measures and if he/she suffers from certain systematic pathology where greater oral control is required to reduce the incidence of periodontal diseases.[29]

Dental cleaning complements

Manual or electronic toothbrushing does not remove 100% of the biofilm, even in people who perform correct brushing movements. In addition to tooth brushing, other oral cleaning methods should be used, such as mouthwash, and interdental brushing to prevent caries and other dental diseases.[30] Likewise, combining brushing with toothpaste or rinses counteracts the development of caries by partially eliminating the biofilm, although this causes the plaque to be in an immature state and thus generates an imbalance in homeostasis and the oral cavity.[31] To maximize the effectiveness of these oral hygiene supplements in combating biofilm, it is crucial to reduce excessive consumption of fermentable carbohydrates, as they are the primary cause of dysbiosis leading to dental caries.[32]

Interdental brushes

Several findings showed that interdental brushes are the most practical and convenient method to counteract the spread of interdental plaque compared to other interdental cleaning implements.[33] One of the consensus conclusions from the 2015 European Federation of Periodontology workshop states that "cleaning with interdental brushes is the most effective method for interproximal plaque removal and is consistently associated with greater plaque removal than flossing or wooden sticks."[28] The functionality of interdental brushes is since the bristles can better fill the dental pockets known as the narrow spaces located between teeth and compromise exposed irregularities on root surfaces.[34]

Discussion

Generally, people brush their teeth for multiple reasons such as avoiding bad breath and counteracting dental pathologies, and thus being able to maintain a healthy oral hygiene. Prevention strategies for periodontal diseases that patients can apply at home not only involve having an adequate toothbrush but also using certain implements

or habits that involve a reduced growth of pathogenic microbial agents such as fluoride toothpastes, reducing the excessive consumption of sugary and/or acidic foods and periodically maintaining a prevention and treatment plan with a dental professional to promote an ideal microenvironment for a balanced microbiome.[35,36]

Toothbrush choice is largely a matter of personal choice, affordability, and guidance by a dentist. Electric toothbrushes may have a special appeal to a sector of users, as they offer a "high-tech" solution for proper brushing. It can prevent periodontal disease and certainly prevents caries when used in conjunction with fluoride toothpaste.[37]

Toothbrushes are highly recommended for oral care. The fact that electronic toothbrushes remove more plaque than manual toothbrushes raises the question of whether people should continue using manual toothbrushes.[38] Electronic toothbrushes are generally more expensive than manual toothbrushes and are available in different variants, including those designed for pediatric or adult patients. It is important to assess the cost-benefit ratio of reducing the risk of caries. Gum disease contributes significantly to chewing dysfunction, which negatively impacts overall health and results in substantial dental care costs. Consequently, effective biofilm removal indirectly reduces the need for treatment.[39]

Research evaluating biofilm reduction before and after brushing among populations using manual and electronic toothbrushes has yielded mixed results. Some studies suggest the superiority of electric toothbrushes, whereas others argue that the difference is not significant or nonexistent.[40]

Although it is generally accepted that proper manual brushing, following instructions and for the recommended duration, can achieve adequate biofilm removal, individuals who predominantly use manual toothbrushes may face challenges in achieving optimal oral cleanliness.[41] The use of an electric toothbrush provides individuals with the ability to achieve optimal plaque reduction and improve gingival health, regardless of manual dexterity or training. This confers a good brushing technique to all users.[42]

The bristles of a toothbrush play a crucial role in oral hygiene. Rounded bristles are generally less aggressive since their softness avoids injury to gingival tissues. Whereas needle-shaped bristles can be potentially more aggressive, generating enamel erosions and gingival recessions if not used with a correct hygiene technique. In addition, it is important to consider that the brush material can influence the characteristics of the denture materials, therefore, it is necessary to use an adequate brushing technique and material.[8,9,19]

Among the limitations for the execution of the study is the lack of free articles in the database platform. Also, part of certain articles presented a position on a certain type of brush, but it was mentioned that further studies are needed to determine a more truthful conclusion. The strengths and importance of this research study are that it highlights the global impact caused by the most common dental diseases such as caries, gingival, and periodontal disease. Due to this problem, there is continuous progress in the development of both manual and high-tech electronic toothbrushes to reduce the number of these diseases.

Conclusions

Based on the research articles, it became evident that some studies found no significant difference in the removal of bacterial plaque in the use of the electronic toothbrush compared to the manual one. On the other hand, a greater number of studies showed greater efficacy in the elimination of bacterial biofilm due to its high level of technology, preventing gingival and periodontal diseases and generating professional brushing in the operators. To summarize, it is not possible to give a conclusion because there is a discrepancy between the authors, and further studies are needed to corroborate and contrast the low or high usefulness of manual and electronic toothbrushes. However, the studies agree on the need for dental hygiene complements since a toothbrush partially removes bacterial plaque.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Authors' contribution

Concept: SC, SG, DAT, and FMT. Design: SC, SG, FEC, DAT, and JBO. Definition of Intellectual content: SC, SG, and FMT. Investigation: SC, SG, FEC, and JBO. Manuscript writing: SC, SG, FEC, DAT, JBO, and FMT.

Ethical policy and institutional review board statement

Not applicable.

Patient declaration of consent

Not applicable.

Data availability statement

Not applicable.

References

1. Duangthip D, Chu CH. Challenges in Oral Hygiene and Oral Health Policy. Front Oral Health 2020;1:575428-5754231.

2. Kovaľová E, Novák B, Klamárová T, Eliašová A. The impact of toothbrush filament design on gingival health during healing A randomized, controlled, investigator-blinded clinical trial. Health Prob Civil 2015;1:47-53.
3. Schnabl D, Wiesmüller V, Hönlinger V, Wimmer S, Bruckmoser E, Kapferer-Seebacher I. Cleansing efficacy of an auto-cleaning electronic toothbrushing device: a randomized-controlled crossover pilot study. Clin Oral Investig 2021;25:247-53.
4. Corbet E, Smales R. Oral diagnosis and treatment planning: Part 6 Preventive and treatment planning for periodontal disease. Br Dent J 2012;213:277-84.
5. Kulkarni P, Singh DK, Jalaluddin M. Comparison of efficacy of manual and powered toothbrushes in plaque control and gingival inflammation: A clinical study among the population of east Indian region. J Int Soc Prev Community Dent 2017;7:168-74.
6. Ng C, Tsoi JKH, Lo ECM. Matinlinna AJP Safety and design aspects of powered toothbrush-A narrative review. Dent J (Basel) 2020;8:1-25.
7. Nammi K, Starke EM, Ou SS, Ward M, Jenkins W, Milleman JL, *et al*. The Effects of Use of a Powered and a Manual Home Oral Hygiene Regimen on Plaque and Gum Health in an Orthodontic Population. J Clin Dent 2019;30:1-8.
8. Deery C, Heanue M, Deacon S, Robinson PG, Walmsley AD, Worthington H, *et al*. The effectiveness of manual versus powered toothbrushes for dental health: a systematic review. J Dent 2004;32:197-211.
9. Cronin MJ, Dembling WZ, Cugini MA, Thompson MC, Warren PR. Three-month assessment of safety and efficacy of two electric toothbrushes. J Dent 2005;33:23-8.
10. Pitts NB, Twetman S, Fisher J, Marsh PD. Understanding dental caries as a non-communicable disease. Br Dent J 2021;231:749-53.
11. Sreenivasan PK, Prasad KVV. Distribution of dental plaque and gingivitis within the dental arches. J Int Med Res 2017;45:1585-96.
12. Chapple ILC, Mealey BL, Van Dyke TE, Bartold PM, Dommisch H, Eickholz P, *et al*. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Clin Periodontol 2018;45:68-77.
13. Jepsen S, Blanco J, Buchalla W, Carvalho JC, Dietrich T, Dörfer C, *et al*. Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol 2017;44:85-93.
14. Jiang Q, Liu J, Chen L, Gan N, Yang D. The Oral Microbiome in the Elderly With Dental Caries and Health. Front Cell Infect Microbiol 2019;8:442-52.
15. Yan Y, Zhan Y, Wang X, Hou J. Clinical evaluation of ultrasonic subgingival debridement versus ultrasonic subgingival scaling combined with manual root planing in the treatment of periodontitis: study protocol for a randomized controlled trial. Trials 2020;21:113-20.
16. Ritter A. V., Walter R. Sturdevant's Art and Science of Operative Dentistry. 7th. Amsterdam, Netherlands: Elsevier; 2018.
17. Khan AA, Zehra F, Venkittu P, Thatchayani I, Harishma CV, Shafna S. A comparative clinical study. J Pharm Bioallied Sci 2022;14:1000-3.
18. Cugini M, Warren PR. The Oral-B CrossAction manual toothbrush: a 5-year literature review. J Can Dent Assoc 2006;72:323-5.
19. Lang NP, Cumming BR, Löe H. Toothbrushing frequency as it relates to plaque development and gingival health. J Periodontol 1973;44:396-405.
20. Creeth JE, Gallagher A, Sowinski J, Bowman J, Barrett K, Lowe S, *et al*. The effect of brushing time and dentifrice on dental plaque removal in vivo. J Dent Hyg 2009;83:111-6.
21. Ng C, Tsoi JKH, Lo ECM, Matinlinna AJP. Safety and design aspects of powered toothbrush-A narrative review. Dent J 2020;8: 1-25.
22. Starke EM, Ward M, Olson M, Ou S-S, Milleman KR, Milleman JL. A randomized parallel study to compare the effects of powered and manual tooth brushing on gingival health and plaque. J Clin Dent 2019;30:16-23.
23. Klonowicz D, Czerwinska M, Sirvent A, Gatignol JP. A new tooth brushing approach supported by an innovative hybrid toothbrush-compared reduction of dental plaque after a single use versus an oscillating-rotating powered toothbrush. BMC Oral Health 2018;18:185-93.
24. Rosema N, Slot DE, van Palenstein Helderman WH, Wiggelinkhuizen L, van der Weijden GA. The efficacy of powered toothbrushes following a brushing exercise: a systematic review. Int J Dent Hyg 2016;14:29-41.
25. Bain C, Sayed AA, Kaklamanos EG, Kazi HAA. Toothbrushing–should we advise mechanical or power brushes? Results of an international Delphi conference. J Contemp Dent Pract 2018;19:1169-73.
26. Ccahuana-Vasquez RA, Adam R, Conde E, Grender JM, Cunningham P, Goyal CR, *et al*. A 5-week randomized clinical evaluation of a novel electric toothbrush head with regular and tapered bristles versus a manual toothbrush for reduction of gingivitis and plaque. Int J Dent Hyg 2019;17:153-60.
27. Nehme M, Parkinson CR, Zero DT, Hara AT. Randomised study of the effects of fluoride and time on in situ remineralisation of acid-softened enamel. Clin Oral Investig 2019;23:4455-63.
28. Verma S, Bhat KM. Acceptability of powered toothbrushes for elderly individuals. J Public Health Dent 2004;64:115-7.
29. Barbe AG, Al-Barwari A, Hamacher S, Deinzer R, Weik U, Noack MJ. Effectiveness of brushing teeth in patients with reduced oral hygiene by laypeople: a randomized, controlled study. BMC Oral Health 2021;21:225-37.
30. Tawakoli PN, Sauer B, Becker K, Buchalla W, Attin T. Interproximal biofilm removal by intervallic use of a sonic toothbrush compared to an oral irrigation system. BMC Oral. Health 2015;15:91-8.
31. Hernández P, Sánchez MC, Llama-Palacios A, Ciudad MJ, Collado L. Strategies to Combat Caries by Maintaining the Integrity of Biofilm and Homeostasis during the Rapid Phase of Supragingival Plaque Formation. Antibiotics (Basel) 2022;11:880-97.
32. Feldens CA, Rodrigues PH, de Anastácio G, Vítolo MR, Chaffee BW. Feeding frequency in infancy and dental caries in childhood: a prospective cohort study. Int Dent J 2018;68:113-21.
33. Graziani F, Palazzolo A, Gennai S, Karapetsa D, Giuca MR, Cei S, *et al*. Interdental plaque reduction after use of different devices in young subjects with intact papilla: A randomized clinical trial. Int J Dent Hyg 2018;16:389-96.
34. Sanz M, Herrera D, Kebschull M, Chapple I, Jepsen S, Beglundh T, *et al*; EFP Workshop Participants and Methodological Consultants. EFP Workshop Participants and Methodological Consultants Treatment of stage I-III periodontitis-The EFP S3 level clinical practice guideline. J Clin Periodontol 2020;47:4-60.
35. Amezdroz E, Carpenter L, Johnson S, Flood V, Dashper SG, Calache H, *et al*. Feasibility and development of a cariogenic diet scale for epidemiological research. Int J Paediatr Dent 2019;29:310-24.
36. Arweiler NB, Netuschil L. The oral microbiota. Adv Exp Med Biol 2016;902:45-60.
37. Yaacob M, Worthington HV, Deacon SA, Deery C, Walmsley AD, Robinson PG, *et al*. Powered versus manual toothbrushing for oral health. Cochrane Database Syst Rev 2014;2014:5-6.
38. Wainwright J, Sheiham A. An analysis of methods of toothbrushing recommended by dental associations, toothpaste and toothbrush companies and in dental texts. Br Dent J 2014;217:E5-E5.
39. Papapanou PN, Sanz M, Buduneli N, *et al*. Periodontitis: consensus report of workgroup 2 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol 2018;45:162-70.
40. Chandrashekar B, Neelima M, Goel S, Sushma R, Srilatha Y. "Is powered toothbrush better than manual toothbrush in removing dental plaque?" – A cruce randomized double-blind study among differently abled, India. J Indian Soc Periodontol 2017;21:138.
41. Deinzer R, Ebel S, Blättermann H, Weik U, Margraf-Stiksrud JT. to the best of one's abilities is possibly not good enough. BMC Oral Health 2018;18:167-74.

42. Kulkarni P, Singh DK, Jalaluddin M. Comparison of efficacy of manual and powered toothbrushes in plaque control and gingival inflammation: A clinical study among the population of east Indian region. J Int Soc Prev Community Dent 2017;7:168-74.
43. Ramseier C A, Petitat C, Trepp S, Lang NP, Eick S, Adam R, *et al*. Clinical Parameters and Oral Fluid Biomarkers in Gingivitis Subjects using an-Electric Toothbrush with Irrigator vs a Manual Toothbrush Alone over 8 Weeks: A Randomised Controlled Clinical Trial. Oral Health Prev Dent 2021;19:137-47.
44. Davidovich E, Ccahuana-Vasquez RA, Timm H, Grender J, Zini A. Randomised clinical study of plaque removal efficacy of an electric toothbrush in primary and mixed dentition. Int J Paediatr Dent 2021;31:657-63.
45. Ghassemi A, Vorwerk L, Hooper W, Patel V, Sharma N, Qaqish J. Comparative plaque removal efficacy of a new children's powered toothbrush and a manual toothbrush. J Clin Dent 2013;24:1-4.
46. Nightingale KJ, Chinta SK, Agarwal P, Nemelivsky M, Frisina AC, Cao Z, *et al*. Toothbrush efficacy for plaque removal. Int J Dent Hyg 2014;12:251-6.
47. Vorwerk L, Ghassemi A, Hooper W, Patel V, Milleman J, Milleman KJ. Comparative Plaque Removal Efficacy of a New Powered Toothbrush and a Manual Toothbrush. Clin Dent 2016;27:76-9.
48. Conn, Warren-Morris D, Prihoda TJ, Hicks BM, Hernandez EE. Comparison of two Manual Toothbrushes in Effectiveness of Plaque Removal: A pilot study. J Dent Hyg 2017;91:32-9.
49. Erbe C, Klees V, Braunbeck F, Ferrari-Peron P, Ccahuana-Vasquez RA, Timm H, *et al*. Comparative assessment of plaque removal and motivation between a manual toothbrush and an interactive power toothbrush in adolescents with fixed orthodontic appliances: A single-center, examiner-blind randomized controlled trial. Am J Orthod Dentofacial Orthop 2019;155:462-72.