
ORIGINAL ARTICLE

Comparison of two electric toothbrushes: evaluation on orthodontic patients

Jacopo LANZETTI *, Paolo D. MICHIEZZI, Jody COLLURA,
Silvia SABATINI, Sara VILARDI, Andrea DEREGIBUS

Dental School, Section of Ortodontics, Department of Surgical Sciences, University of Turin, Turin, Italy

*Corresponding author: Jacopo Lanzetti, Dental School, Section of Ortodontics, Department of Surgical Sciences, University of Turin, Via Nizza 230, 10126 Turin, Italy. E-mail: jacopo.lanzetti@unito.it

This is an open access article distributed under the terms of the Creative Commons CC BY-NC license which allows users to distribute, remix, adapt and build upon the manuscript, as long as this is not done for commercial purposes, the user gives appropriate credits to the original author(s) and the source (with a link to the formal publication through the relevant DOI), provides a link to the license and indicates if changes were made. Full details on the CC BY-NC 4.0 are available at <https://creativecommons.org/licenses/by-nc/4.0/>.

ABSTRACT

BACKGROUND: The effectiveness of different types of electric toothbrushes in terms of removing bacterial plaque is still a debated issue. The aim of the study was to compare the plaque removal after a single use of two types of electric toothbrushes, sonic and roto-oscillating, in patients with fixed orthodontics.

METHODS: Twenty-five subjects with fixed multibrackets appliances were randomly selected. Plaque scores were detected using a fluorescein-based detector. After using the sonic toothbrush with a surfactant-free toothpaste, the plaque scores were detected again. After 3 months, the procedure is performed again following the same methods, using the roto-oscillating toothbrush. For the statistical analysis a Student's *t*-test using Microsoft Excel 2021 (Microsoft Corp., Redmond, WA, USA) was performed. The differences were considered statistically significant for probability values $P < 0.05$.

RESULTS: It can be seen that the brushing carried out with a sonic technology is more effective than the roto-oscillating technology. However, the FMPS, MOPI and OPI indexes do not show differences between the use of the two toothbrushes. The OHI-S index shows a statistically significant difference using the sonic toothbrush with a significance level of 0.05%.

CONCLUSIONS: It can be said that both electric toothbrushes are effective for maintaining a good home oral hygiene in patients with fixed orthodontics.

(Cite this article as: Lanzetti J, Michienzi PD, Collura J, Sabatini S, Vilardi S, Deregibus A. Comparison of two electric toothbrushes: evaluation on orthodontic patients. Minerva Dent Oral Sc 2023;72:125-30. DOI: 10.23736/S2724-6329.22.04711-8)

KEY WORDS: Tooth; Patients; Dentistry.

The electric toothbrush is a home oral hygiene device used for the mechanical control of bacterial biofilm. The wide variety of electric toothbrushes on the market today can be classified according to the technology that moves the brush head: the two main types of movement are roto-oscillation and vibration. Sonic or super-sonic technology toothbrushes are characterized

by a linear vibratory movement of the bristles and generally have a head that is very similar in shape to a standard manual toothbrush. The peculiarity of this mechanism, which combines about 31000 transverse movements per minute, is the creation of a fluid composed of toothpaste and saliva that, thanks to the hydrodynamic action, can remove the bacterial biofilm even from

surfaces that are not directly reached by the bristles. The action of the fluid extends up to 4 millimeters beyond the tip of the bristles.¹ The operation of the roto-oscillating electric toothbrush, on the other hand, is based on the mechanical action of the brush head, which, by rubbing on the tooth surface, breaks down the bacterial biofilm. The better efficacy of a general-purpose electric toothbrush compared to a traditional one has been widely studied and demonstrated. Comparing two of the most popular toothbrush models, the Philips Sonicare DiamondClean (Philips, Amsterdam, the Netherlands) with premium brush head and the Oral-B 7000 with CrossAction brush head (Procter & Gamble, Cincinnati, OH, USA), the sonic toothbrush, DiamondClean, was statistically significantly superior in reducing supragingival deposits and bleeding rates.² More evolved models of the same toothbrushes were tested by different authors on a similar sample and with the same modalities: a greater efficacy of the sonic toothbrush was shown with a high level of significance in this case as well.³ In contradiction to the articles cited above, a systematic review and meta-analysis comparing a high-frequency sonic toothbrush to a roto-oscillating toothbrush in reducing plaque levels, states that there is significant evidence on the greater efficacy in removing bacterial plaque of the roto-oscillating toothbrush compared to the high-frequency sonic toothbrush, after a single brushing exercise.⁴ A very recent review of the literature⁵ on the use of sonic and roto-oscillating toothbrushes found that there was insufficient evidence to support the superiority of either toothbrush when tested on the general population. In fact, the inclusion criteria used in the review are very broad: no limit of age or belonging to specific social environments and no particular requirements for the patient. This provides the study with high reliability, but, sometimes, it is useful to narrow the scope of the research and examine only a certain type of patients to discover different results. A systematic review⁶ aimed to evaluate the effectiveness of a high-frequency sonic toothbrush on plaque and bleeding levels in patients of various types, including subjects with fixed orthodontic appliances. The article concludes by stating that –

considering the totality of patients – there is not strong enough evidence to support greater efficacy of the sonic toothbrush in terms of reducing inflammation. However, selecting only studies performed on patients wearing fixed orthodontic appliances, a significant reduction in the indexes can be seen following continuous use (minimum six months) of the sonic toothbrush. Many studies agree that the roto-oscillating toothbrush can bring consistent benefits in terms of efficacy and speed to patients with fixed orthodontics⁷⁻¹⁰ because maintaining good oral hygiene is often a complex challenge in the presence of brackets, especially during the puberty period, when there is a risk of experiencing episodes of gingival inflammation much more easily, due to a series of hormonal changes that affect tissue permeability and production of inflammatory mediators. A longitudinal study conducted in a population of 80 adolescents with fixed orthodontic appliances with an average age of about 14 years showed that the use of a roto-oscillating toothbrush significantly affected the reduction of plaque indexes and gingival inflammation, compared with those who had used a manual toothbrush.¹¹ A recent randomized, blinded clinical trial evaluated the efficacy of a roto-oscillating toothbrush with an orthodontic head and a sonic toothbrush with a regular head in patients with fixed orthodontic appliances, using digital plaque image analysis (DPIA) of anterior teeth. The results showed that both treatments produced a statistically significant reduction in plaque compared to baseline of 60.76% for the sonic with a standard head and 65.62% for the roto-oscillating with an orthodontic head, respectively. Notably, the plaque reduction due to the use of the roto-oscillating toothbrush with an orthodontic head was statistically significant compared to the sonic.¹² In another clinical investigation,¹³ 60 patients undergoing fixed orthodontic therapy were divided into three groups: the first received an orthodontic manual toothbrush, the second received a roto-oscillating electric toothbrush, and the third received a sonic toothbrush. Results revealed statistically significant differences both within and between each group. The lowest levels of plaque and gingival inflammation were obtained with the use of the sonic toothbrush, followed

by the roto-oscillating toothbrush and finally the manual toothbrush. As highlighted in the cited articles, the superiority of an electric toothbrush technology in terms of effectiveness in removing bacterial plaque remains a debated issue: the studies are numerous and often conflicting results. The aim of this study was to examine which type of electric toothbrush, between sonic and roto-oscillating, is more effective in reducing bacterial plaque in patients with fixed multibrackets appliances, after a single use.

Materials and methods

A randomized controlled trial (RCT) with an opportunistic sample was developed. The study developed in two operative sessions performed 3 months apart. A simple random sampling was performed, to obtain a representative sample of the population of patients treated in the orthodontic department at Dental School. The patients were randomly distributed in two groups by performing a block randomization. To minimize the variables, all patients used both types of brushing

(Figure 1). Twenty-five subjects between 10 and 25 years of age, wearing fixed multibrackets on both arches, were randomly selected among the patients treated at the Orthodontic Section of the Dental School of Turin. Smoking patients, patients suffering from systemic diseases, patients on antibiotic therapy in the six months preceding the study and users of an electric toothbrush were not included in the study. Subjects participating in the study signed an informed consent to the proposed therapy. The principles described in the Declaration of Helsinki were followed in drafting the informed consent and conducting the study. During the first session (T_0), the following plaque indices were recorded:

- Full Mouth Plaque Score (FMPS) by O'Leary *et al.*;¹⁴
- Orthodontic Plaque Index (OPI) by Declerck *et al.*;¹⁵
- Modified Orthodontic Plaque Index (MOPI) by Beberhold *et al.*;¹⁶
- Oral Hygiene Index Simplified (OHI-S) by Green *et al.*¹⁷

A fluorescent-based plaque detector was used to detect the indices since it is visible only by using a special lamp, so that the patient cannot see where the deposits are located. The operator responsible for data collection was blinded and did not know whether the patient would use the roto-oscillating or the sonic toothbrush. After data collection, the patient was given the sonic toothbrush (Philips FlexCare model) with standard head and instructions on the use of the device were given: the bristles were placed at the level of the gingival sulcus and the patient was asked to change tooth surface every 3 seconds so that each surface was equally cleaned by the toothbrush for a total time of 3 minutes of use of the device. A surfactant-free toothpaste (*e.g.*, Sodium Lauryl Sulfate) is placed on the head, which, having a foaming action,¹⁸ could compromise and affect the fluid-dynamic action of the sonic technology. After 3 minutes, the plaque indices are measured again using the lamp. The next phase involves a professional oral hygiene session, without modifying the patient's home oral hygiene methods. After 3 months (T_1), the second session is performed following the same methods of T_0 with the exception of the type of

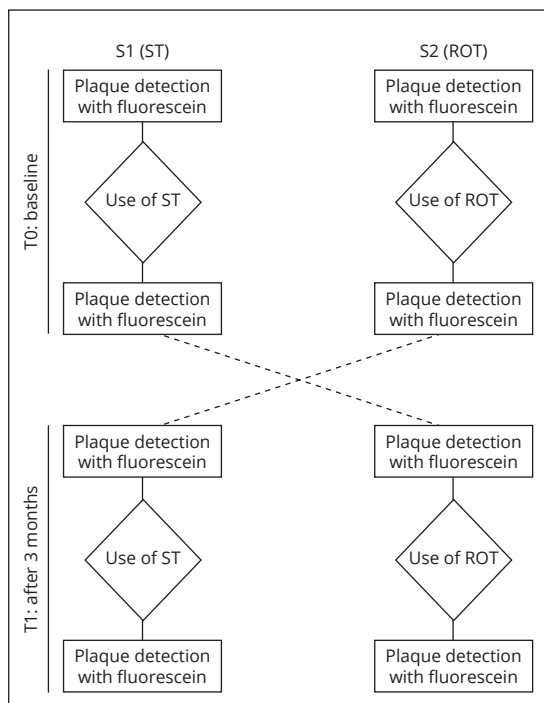


Figure 1.—Flowchart of the study.
ST: sonic toothbrush; ROT: roto-oscillating toothbrush.

electric toothbrush used. In this case, the patient used a roto-oscillating toothbrush (Oral-B Genius model) with a standard head. The models of electric toothbrush to be used by the patients have been chosen since they currently are top of their lines.

Statistical analysis

Statistical analysis was performed using the Microsoft Excel 2021 program (Microsoft Corp., Redmond, WA, USA). The analysis focused on statistically significant differences between the sonic toothbrush and the roto-oscillating toothbrush. Specifically, between the first operating session (T₀) and the second operating session (T₁) regarding the plaque indices detected. The confidence interval at the 0.95 level of the population mean value was calculated, then, to test the true differences, Student's *t*-test was performed to obtain the P value. Differences were considered statistically significant for probability values P<0.05.

Results

Twenty-five patients were included in the research protocol, including 19 females and 6 males (mean age 15.08 years). In the interim between the first session (T₀) and the second (T₁), 2 dropouts occurred. In both pretreatment sessions the FMPS, MOPI, OPI, OHI-S indices did not show a statistically significant difference with a P>0.05, therefore all variables of S1 and S2 can be considered superimposable at baseline. Table I shows the means and confidence intervals of the indices examined before treatment (T₀) and after toothbrush use (T₁) in both groups, sonic (S1) and roto-oscillating (S2). Since statistically significant differences are considered to be prob-

TABLE II.—*P* value of the detected plaque indices.

	FMPS	OHI-S	MOPI	OPI
P value	0.19993	0.00085	0.08348	0.59051

FMPS: Full Mouth Plaque Score; OHI-S: Oral Hygiene Index Simplified; MOPI: Modified Orthodontic Plaque Index; OPI: Orthodontic Plaque Index.

ability values <0.05, the FMPS, MOPI, and OPI indices show no difference between using a sonic and roto-oscillating toothbrush, whereas the OHI-S index shows a statistically significant difference between those using sonic *versus* roto-oscillating technology at a significance level of 0.05%. Table II shows the P values of the respective plaque indices.

Discussion

From the processed data, it can be deduced that both sonic and roto-oscillating toothbrushes are effective in removing bacterial biofilm present on the tooth surfaces of patients undergoing treatment with fixed orthodontic appliances. Statistical analysis showed that the only statistically significant difference is shown for the OHI-S index, while there was no statistically significant difference of the other plaque indices (FMPS, OPI, MOPI) detected at T₀ and T₁. Observing the trend of the data, it can be seen that brushing performed with sonic technology is more effective than roto-oscillating technology. Specifically, for the FMPS plaque index, sonic technology was able to remove 49.15% of plaque compared to 40.75% for roto-oscillation technology; the OPI index recorded 36.96% plaque removal for the sonic group compared to 34.83% for the roto-oscillation group; the MOPI index recorded a level of oral hygiene of 2.4 with a sonic toothbrush compared to 2.78 with a roto-oscillating toothbrush; finally, for the OHI-S index it can be noted

TABLE I.—*Averages and confidence intervals of the plaque indices detected at T₀ and T₁ in the two groups.*

	T ₀		T ₁		ΔT	
	S1: average±95% CI	S2: average±95% CI	S1: average±95% CI	S2: average±95% CI	S1: average	S2: average
FMPS	93.46%±0.0547	92.09%±0.0804	44.31%±0.1501	51.34%±0.2792	49.15%	40.75%
OHI-S	2.07±0.7611	2.03±0.5005	0.75±0.4761	1.25±0.6123	1.32	0.78
MOPI	3.68±0.05568	3.72±0.6137	2.4±0.8165	2.78±0.8175	1.28	0.94
OPI	73.1%±0.1211	73.23%±0.1436	36.14%±0.1501	38.4%±0.1936	36.96%	34.83%

The ΔT values indicate the amount of plaque removed in the two groups.
 FMPS: Full Mouth Plaque Score; OHI-S: Oral Hygiene Index Simplified; MOPI: Modified Orthodontic Plaque Index; OPI: Orthodontic Plaque Index.

that after a single brushing with sonic technology a level of oral hygiene of 0.75 was reached, “good” considering the specific scale, while with roto-oscillating technology a value of 1.25, between “good” and “sufficient.” Clinically, a higher efficiency of gingival margin cleansing of the sonic toothbrush and a preference of the latter by the patient can be noticed. This difference can be explained using two different head shapes: round for the roto-oscillating garment and rectangular of elongated shape for the sonic garment. The latter turned out to be more adequate and easily adaptable to the lateral surfaces of the brackets, favoring a better removal of bacterial biofilm. However, we can see that the FMPS levels detected after using the electric toothbrush remain very high (>50%). This result explains how hard it can be to maintain a good oral hygiene for the orthodontic patients. Moreover, we can say that a single use of an electric toothbrush is not enough to reduce the plaque level in a patient with fixed orthodontics.

Conclusions

From the analysis of the data collected, a statistically significant difference can be observed only for the OHI-S plaque index which records a P value of 0.00085 for a significance level <0.05. As for the MOPI, FMPS and OPI indices, the difference recorded between the two toothbrushes was not statistically significant. In conclusion, we can state that both sonic and roto-oscillating toothbrush are effective in maintaining good home oral hygiene in the patient wearing fixed orthodontics. In addition, we must consider that oral hygiene motivation and individual manual dexterity play a decisive role in maintaining favorable levels of hygiene, whatever instrument we choose to use. Among the various evidence supporting this thesis, it is worth mentioning a study¹⁹ that evaluated the actual impact of rigorous instruction and motivation on some patients undergoing treatment with fixed multibrackets equipment. The 66 recruited subjects were assigned different types of toothbrushes, both electric and manual. Subsequently, the patients underwent partly five consecutive sessions of home oral hygiene instruction and motivation one

month apart from each other and partly one session at the beginning of the study. Evaluations of plaque indices recorded throughout the study period showed the decisive role that repeated motivation over time had on improving and maintaining oral hygiene, regardless of the toothbrush used. In the future, it would be interesting to verify the findings with a larger sample and compare the sonic toothbrush with a magnetically driven roto-oscillating toothbrush. This new technology is based on the roto-oscillating motion and adds a mechanism of magnetically transmitted microvibrations to the bristle tip of the brush head, promoting quieter and more effective brushing. In addition, it would be interesting to evaluate whether the different types of brush heads and filament arrangement would change the effectiveness of the toothbrush itself. The only clinical study currently available related to this new type of roto-oscillating toothbrush²⁰ analyzed its efficacy compared to that of a sonic toothbrush and a manual toothbrush, showing that this new technology achieved a significant reduction in plaque index compared to the other two toothbrushes and provided significant benefits to the patient’s gum health.

References

1. Stanford CM, Srikantha R, Wu CD. Efficacy of the Sonicare toothbrush fluid dynamic action on removal of human supragingival plaque. *J Clin Dent* 1997;8:10–4.
2. Starke M, Delaurenti M, Ward M, Souza S, Milleman KR, Milleman JL. A comparison of the effect of two power toothbrushes on the gingival health and plaque status of subjects with moderate gingivitis. *J Clin Dent* 2017;28:A29–35.
3. Mirza F, Argosino K, Ward M, Ou SS, Milleman KR, Milleman JL. A Comparison of the effect of two power toothbrushes on the reduction of gingival inflammation and supragingival plaque. *J Clin Dent* 2019;30:A9–15.
4. van der Sluijs E, Slot DE, Hennequin-Hoenderdos NL, Valkenburg C, van der Weijden F. Dental plaque score reduction with an oscillating-rotating power toothbrush and a high-frequency sonic power toothbrush: a systematic review and meta-analysis of single-brushing exercises. *Int J Dent Hyg* 2021;19:78–92.
5. El-Chami H, Younis A, Brignardello-Petersen R. Efficacy of oscillating rotating versus side-to-side powered toothbrushes on plaque and gingival index reduction: A systematic review. *J Am Dent Assoc* 2021;152:115–126.e4.
6. Costa MR, Marcantonio RA, Cirelli JA. Comparison of manual versus sonic and ultrasonic toothbrushes: a review. *Int J Dent Hyg* 2007;5:75–81.
7. Silvestrini Biavati A, Gastaldo L, Dessi M, Silvestrini Biavati F, Migliorati M. Manual orthodontic vs. oscillating-rotat-

ing electric toothbrush in orthodontic patients: a randomised clinical trial. *Eur J Paediatr Dent* 2010;11:200–2.

8. Heintze SD, Jost-Brinkmann PG, Loundos J. Effectiveness of three different types of electric toothbrushes compared with a manual technique in orthodontic patients. *Am J Orthod Dentofacial Orthop* 1996;110:630–8.

9. Park CH, Hwang, Hyeon- Shink, Lee, Ki-Heon, Hong, Suk Jin A comparative study of electric and manual toothbrushes on oral hygiene status in fixed orthodontic patients. *Korean J Orthod* 2004;34:363–70.

10. Zorina OA, Boriskina OA, Starikova NV, Petrukhina NB, Nechaev AA, Prohodnaja VA. [Influence of different type of toothbrushes on gingival fluid proteolytic potential during orthodontic treatment]. *Stomatologia (Mosk)* 2020;99:22–6. [Russian]

11. Borutta A, Pala E, Fischer T. Effectiveness of a powered toothbrush compared with a manual toothbrush for orthodontic patients with fixed appliances. *J Clin Dent* 2002;13:131–7.

12. Erbe C, Jacobs C, Klukowska M, Timm H, Grender J, Wehrbein H. A randomized clinical trial to evaluate the plaque removal efficacy of an oscillating-rotating toothbrush versus a sonic toothbrush in orthodontic patients using digital imaging analysis of the anterior dentition. *Angle Orthod* 2019;89:385–90.

13. Shah VR. Comparison of Manual Orthodontic, Powered

and Sonic Toothbrushes in patients undergoing Fixed Orthodontics. *J Adv Med Dent Scie Res* 2020;8:143–6.

14. O'Leary TJ, Drake RB, Naylor JE. The plaque control record. *J Periodontol* 1972;43:38.

15. Declerck D, Lesaffre E. *KU Leuven Special Issue: Statistical Methods in Oral Health Research. Stat Model* 2014;14(6).

16. Beberhold K, Sachse-Kulp A, Schweska-Polly R, Hornecker E, Ziebolz D. The Orthodontic Plaque Index: an oral hygiene index for patients with multibracket appliances. *Orthodontics (Chic)* 2012;13:94–9.

17. Greene JC, Vermillion JR. The Simplified Oral Hygiene Index. *J Am Dent Assoc* 1964;68:7–13.

18. Brown RS, Smith L, Glascoe AL. Inflammatory reaction of the anterior dorsal tongue presumably to sodium lauryl sulfate within toothpastes: a triple case report. *Oral Surg Oral Med Oral Pathol Oral Radiol* 2018;125:e17–21.

19. Marini I, Bortolotti F, Parenti SI, Gatto MR, Bonetti GA. Combined effects of repeated oral hygiene motivation and type of toothbrush on orthodontic patients: a blind randomized clinical trial. *Angle Orthod* 2014;84:896–901.

20. Adam R. Introducing the Oral-B iO electric toothbrush: next generation oscillating-rotating technology. *Int Dent J* 2020;70:S1–6.

Conflicts of interest.—The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

Authors' contributions.—Jacopo Lanzetti, Paolo D. Michienzi, Jody Collura, Graziana Maggiore and Jacopo Lanzetti have given substantial contributions to the data acquisition and interpretation, and to the manuscript draft; Sara Vilardi and Silvia Sabatini contributed to the manuscript draft; Jacopo Lanzetti and Andrea P. Deregibus contributed to the study conception and design, and to the critical revision. All authors read and approved the final version of the manuscript.

History.—Manuscript accepted: October 3, 2022. - Manuscript revised: September 15, 2022. - Manuscript received: April 19, 2022.