

## CLINICAL STUDIES REGARDING DENTAL BRUSHING PERFORMANCE: MANUAL VS. THREE-DIMENSIONALLY ELECTRIC BRUSHING: A PROSPECTIVE SPLIT MOUTH DESIGN STUDY

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### ABSTRACT

The aim of the present clinical study was to study the efficiency of electric toothbrushing when comparing it to the classical manual Bass method. During our research we looked at the concept of efficiency, the ergonomics of the electric and classic toothbrush, as well as their ability to remove as much as possible the bacterial plaque on the surface of the teeth, from the interdental spaces and from the superficial marginal periodontium. The group consisted of 114 subjects aged between 16-50 years of which 60 were women representing 52.63% and 54 were men representing 47.36%, coming from different social backgrounds. Plaque index (PI) and papilla bleeding indices (PBI) were evaluated during a period of six weeks using the direct method with the dental probe or the indirect method using plaque detectors. At the end of the clinical trial, there were clear differences between the efficiency of electric and manual brushing. When examining the right side brushed manually IP registered values lower than 1 in a number of 64 (56.1%) of the examined persons, the rest of 50 (43.9%) showing values between 1-1.5. The PBI index on the right-side recorded scores below 0.3 to 43 (37.7%) of subjects, while the remaining 71 (62.3%) had values between 0.3-0.6. On the left-side, sanitized with the electrically operated brush, the average IP with values less than 1 was determined in a number of 103 (90.4%) subjects, the remaining 9 subjects (9.6%) showing values between 1-1.5. Regarding the values of PBI on the left-side, 91 subjects had values below 0.3 and the remaining 23 (20.2%) patients recorded values between 0.3 -0.6 One explanation for these results is that the easy technique of the electric sanitizing variant leads to a maintenance of the technique unaltered over time, which in the case of manual brushing cannot be verified.

**Keywords:** electric toothbrush, classic toothbrush, Bass method, oral sides

### INTRODUCTION

Dental brushing is currently an indispensable method for removing dental plaque deposits on the tooth surfaces and soft tissues of the superficial marginal periodontium.

Researchers have made sustained efforts to develop the most effective toothbrushing techniques possible, so in recent years the focus has been on methods of removing plaque with electrically operated

toothbrushes rather than manual brushing techniques. It is well known and studied that brushing is currently an indispensable method of removing bacterial plaque deposits despite all efforts to find an alternative solution that is easier to apply and accept by patients [1]. Researchers have made sustained efforts to develop the most effective toothbrushing techniques possible, so in recent years the focus has been on methods of removing plaque with electrically operated toothbrushes [2-3]. If at the time of their appearance electric toothbrushes were intended for people with mental or motor disabilities who have no skills [4], today the technical and electronic evolution of these electrical devices to combat plaque deposits and food debris is recommended to all patients, whether adults or children [5]. Most patients use an untimely brushing technique with low efficiency for the correct removal of bacterial plaque [6-10]. Beals et al. [9] in their clinical investigation, in addition to the practical testing of the performance of some scientific brushing techniques, found out that there is also the benefit of the patient to be professionally trained by the dentist regarding a methodical control of bacterial plaque at the level of oral cavity structures. When comparing our clinical observations with data from the literature, there is no doubt that there is a need for a study on the problem of optimal mechanical cleaning of dental surfaces, and of the marginal periodontium at this level. Therefore, the aim of the present clinical study was to make a comparison of the efficiency of electric toothbrushing with the classical manual Bass brushing method. During the research we looked at the concept of efficiency, the ergonomics of the electric

and classic toothbrush, as well as their ability to remove as much as possible the bacterial plaque on the surface of the teeth, from the interdental spaces and from the marginal periodontium. We also wanted to see what are the subjective and objective elements that motivate the patient in the decision to opt for one method or another that will ultimately lead to achieving and maintaining optimal oral hygiene.

## **MATERIAL AND METHOD**

For examination, we chose a heterogeneous group consisting of 114 subjects aged between 16-50 years. The examined group consisted of 60 women representing 52.63% and 54 men representing 47.36%, coming from different social backgrounds, who presented themselves between May 2021 to July 2021 at the Discipline of Preventive and Community Dentistry within G.E. Palade University of Medicine, Pharmacy, Sciences and Technology of Tîrgu Mureş, Romania for sanitation or prophylactic treatments.

The inclusion criteria were as follows:

1. Healthy patients with no general condition that could influence the results of the research
2. Non-smoking patients
3. Intact dental arches
4. Teeth completely erupted

The exclusion criteria were as follows:

1. Patients taking medication that could influence the results
2. Patients undergoing orthodontic treatment
3. Prosthetic dental rehabilitation present in the oral cavity

All patients were presented in detail with the steps and procedures to be followed, after which the participants gave their written consent to be included in the study group. None of the selected patients have been instructed in the last 12 months by the dentist regarding Bass's brushing technique, nor did they use the electric brushing method performing a scientifically unqualified manual toothbrushing. In the first stage of the clinical trial, we determined the Silness and Løe mean plaque index (PI) by the direct method using a dental probe on all teeth present (Figure 1) and Muhlemann's interdental papilla bleeding index (PBI) to determine the status of oral hygiene and periodontal inflammation in the study group. The average score of each tooth was determined by dividing the sum of the scores of each dental surface by 4. The average plaque index of the patient was obtained by the sum of the average score of each tooth divided by the number of teeth examined.



**Fig 1. Determination of the PI by the direct method**

In the next phase of the study, we resorted to the indirect method of highlighting the

bacterial plaque using plaque detectors, in our case using tablets that color the plaque red or blue. Highlighting plaque with plaque detectors had a dual purpose, namely, to accurately detect areas of toothbrush deficiency as well as to demonstrate to patients the incorrectness and ineffectiveness of the untimely technique they practiced until the time of inclusion in the study (Figure 2). As suggested by other researchers [11] this method led to strong patient motivation during our research also.



**Fig 2. Detection of bacterial plaque by means of indirect method**

Later in the study we explained, demonstrated, and train patients to perform the mixed dental-periodontal Bass brushing technique, using an oversized mock-up, plates, and videos to better understand the movements that need to be imprinted on the active part of the toothbrush. At the same time, we presented to the patients the electric toothbrush (Oral-B Cross Action™) with the latest three-dimensional action, and we exemplified its correct use on the same models.

For the manual Bass technique and electric

brushing, the protocol followed was:

- The brush is applied on the vestibular face of the last tooth on the right maxillary hemi-arch, parallel to the occlusion plane, at an angle of 45° in front of the longitudinal axis of the teeth in contact with the gingival margin.

- Brushing is performed on groups of teeth (the number of teeth in the group is dictated by the length of the brush head and the teeth size.

- Brush pressure and vibration movements will be performed on the spot, 5-6 times, without disengaging the strands from the cervical.

- In the first phase, the vestibular faces of the maxillary teeth will be acted upon, then the occlusal faces will be brushed by energetic horizontal movements, and then the oral faces will be acted upon.

-The brushing of the oral faces is done in the same way as of the vestibular faces, with the mention that at the level of the frontal group the brush will be positioned vertically to ensure a better access to those areas.  
-Attention will be paid to brushing the vestibular face of the canine, which being in the area of maximum convexity of the arch, will be bet on segments and namely the distal-vestibular half with the premolar group and the mesial half with the frontal group.

The same rules will be followed for the mandibular jaw, the difference being that the brushing starts with the last tooth on the left and advances to the right. We used the split-mouth concept introduced by Ramfjord in 1968 verified by other previous researchers [9] thus dividing the oral cavity into two

halves along the sagittal axis obtaining a left and a right side. Each half of the oral cavity contained the upper and lower hemiarches on the same side. Later in the study we asked patients to clean the right half using the classic Bass technique and the left half using electric brushing following the previous mentioned protocol. Each hemiarch was brushed for 1 minute, so brushing each side of the oral cavity took 2 minutes recommended time to be optimal for good hygiene results. Thus, we were able to compare the efficiency of the two brushing methods simultaneously by determining the average plaque index for each half of the oral cavity, and we did the same with the PBI index. In the next stage of the investigation, the patients were recalled at an interval of 2,4 and 6 weeks to perform redetermination of the PI and PBI indices, as well as to follow the correctness of the applied brushing techniques. Motivation was achieved at each check with the help of plaque revealers.

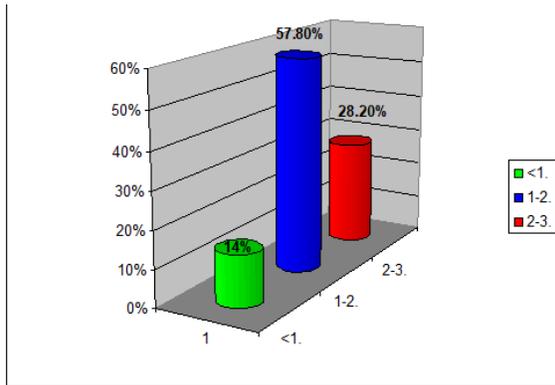
#### STATISTICAL ANALYSIS

All data was recorder using Microsoft Excel software, 2017 version, for Windows 10™. Statistical analysis was performed using the Kruskal-Wallis for independent data with the aid of GraphPad Prism™, 6<sup>th</sup> version.

#### RESULTS

Following the initial determination of the plaque index (PI) in the whole group, we reached the following results: 16 of the patients (14%) had an average bacterial plaque index between 0-1, which represents a satisfactory oral hygiene. In the case of 66 patients (57.8%) we determined an average

bacterial plaque index, between 1-2, this score representing a poor oral hygiene and 32 patients (28.2%) an average bacterial plaque index between 2-3 and this, proving a totally unsatisfactory oral hygiene (Graph 1).

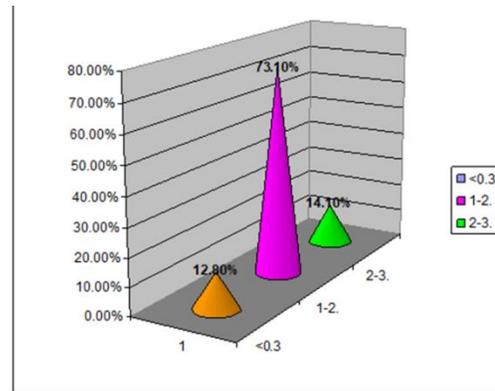


**Graph 1. Results of the Plaque Index at the initial examination**

Also, at the initial examination following the determination of the interdental papilla bleeding index (PBI), 15 subjects (12.8%) of the patients had a bleeding index of 0.3, which indicates the absence of gingival inflammation, 83 subjects (73.1%) had a bleeding index with values between 1-2, which represents a moderate gingival inflammation and 16 (14.1%) of patients have a PBI index with values between 2-3, which is neglecting to maintain proper oral hygiene (Graph 2).

After 2 weeks from the introduction of the 2 brushing methods, the plaque index ranged from 0-1 in 82 (71.7%) of the subjects and the remaining 32 (28.3%) had an IP between the score of 1-1.5. On the right hemiarches that were brushed using the Bass method. At the level of the left hemiarches brushed with the help of the electrical toothbrush device, values between 0-1 to 102 (89.4%) of the

examined patients, the remaining 12 (10.6%) having scores between 1-1.5 were recorded.



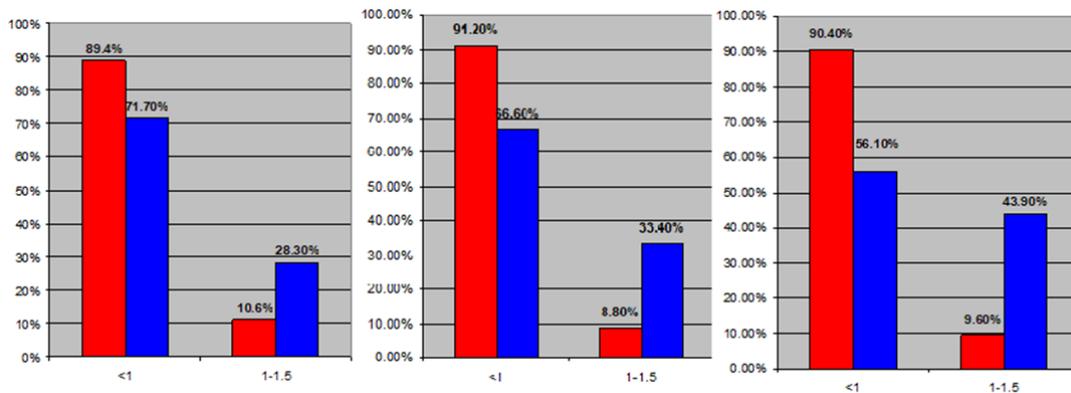
**Graph 2. Results of the Papilla Bleeding Index at the initial examination**

It should be noted that no patient has been registered with an average plaque index greater than 1.5 regardless of the method used. However, in the case of the electric brushing method, the percentage of those with optimal oral hygiene was higher (Graph 3). Regarding the PBI index, 43 (37.7%) of the subjects were detected with values lower than 0.3 and 71 (62.3%) with values between 0.3-0.6 at the level of the hemiarches brushed with the Bass technique. On the electrically sanitized left side, PBI values below 0.3 in 70 (61.4%) and 44 subjects (38.6%) showing values between 0.3-0.6 were recorded (Graph 4).

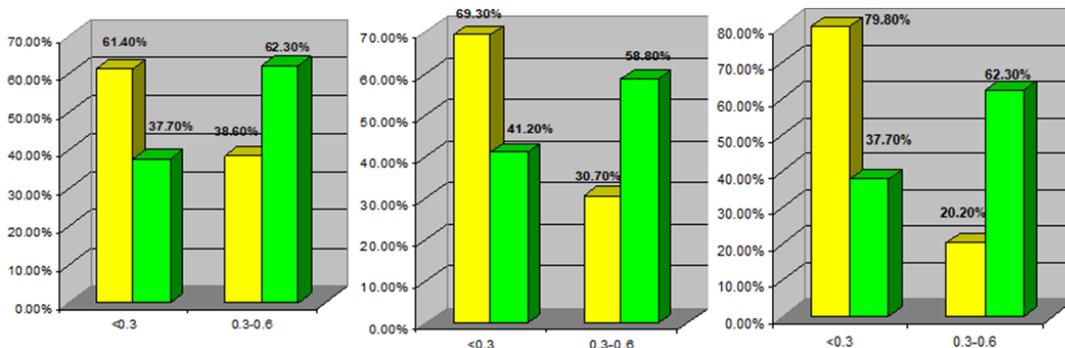
Analyzing the percentage of PI and PBI scores, we can state that after 4 weeks the advantage of electric toothbrushing is accentuated, obtaining better results. PBI values that improve over time only in the case of electric brushing demonstrate its superior ability to perform gingival massage,

stimulating the circulation and keratinization rate of epithelial cells in the gums. At the last check-up of 6 weeks, the two indices' averages registered the following values: for the right side brushed manually, PI registered values lower than 1 in 64 (56.1%) of the examined persons, the rest of 50 (43.9%) showing values between 1-1.5 (Graph 3). The PBI index on the right side scored below 0.3 in 43 (37.7%) of cases, while 71 (62.3%)

had ranged between 0.3-0.6. On the left side, sanitized with the electrically operated brush, the average PI values less than 1 were determined in 103 (90.4%) subjects, while the remaining 9 (9.6%) showed values between 1-1.5. Regarding the values of PBI on the left side, 91 subjects had values below 0.3 and other 23 (20.2%) patients recorded values between 0.3-0.6 (Graph4).



**Graph 3. Comparative results of the plaque index at two, four and six weeks of the initial examination**



**Graph 4. Comparative results of the Papilla Bleeding Index at two, four and six weeks of the initial examination**

## DISCUSSIONS

It is known that without proper motivation of the patient, any brushing technique will not be performed correctly which leads to an inability to optimally sanitize dental surfaces. According to recent studies in the literature [3-7], motivation is an essential element in brushing teeth, depending in 50% on the success of a good mechanical cleaning of plaque and food debris. Following the usual dental brushing of the patients, demonstrated by them in the dental office, we can state that: 51 subjects (44.7%) insisted only on the frontal group or at most until premolars and more vestibular, the lateral areas of the arch being neglected. In 103 patients (90.3%) the duration of tooth brushing was between 60-80 seconds which is insufficient time for optimal brushing. 56 subjects (49.1%) performed horizontal movements of the active part of the brush, thus exposing the marginal periodontium to traumas that can lead to the gingival retraction. 42 patients (36.8%) used toothbrushes whose active ends no longer corresponded ergonomically because they had a degree of wear above the acceptable limit. When comparing the data obtained by us with the results of studies published in the literature by Al Wahandi et al. 2004 [10], we can conclude that the status of oral hygiene at the level of the study group is quite precarious, the percentage of those with PI between 1-2 was very high. After analyzing and interpreting the data obtained from the clinical determinations of plaque index and interdental papilla bleeding index we could follow objectively and subjectively the efficiency and acceptance by

participants in this study of various methods of removing bacterial plaque. The results obtained by us largely coincided with those published in the literature by Wolf et al. 2006 [11] who stated that the Bass technique was mastered with greater effort by the study group population and only in need of permanent minor corrections in the various stages of the research. Most of the patients had shown a keen interest in using a scientifically documented brushing technique that leads to better dental-periodontal status.

All subjects without exception noted the ease of use of the electric toothbrush, the lack of difficulties in mastering and applying the brushing technique, and the ease of use and maintenance of the electric toothbrush. None of those who participated in this study would choose the classic brushing method. These much-improved scores are objective elements that indicate a good efficiency of mixed dental-gingival brushing according to the Bass method, and a higher efficiency in the case of electric brushing. Hainoka et al. [12] have studied the effectiveness of electric brushing, concluding that this sanitizing solution is a viable method of combating bacterial plaque. Further studies conducted by Doherty et al. [13] demonstrated the superior efficiency of the electric brushing performed with the device used by us as well in the study.

All patients in the study group were receptive to the control session after 14 days showing a high interest in plaque revealing tablets by which we highlighted the correctness of the brushing technique applied and thus reducing

the amount of bacterial plaque deposited or accumulated in the structures of the oral cavity, especially dental-periodontal units.

Also, we found that the vast majority of patients had a keen interest in combating bacterial plaque and stated that they performed 2 brushings a day as directed by the first session. No patient had gingival lesions caused by the brushing options applied.

Another great advantage of electric brushing is that these devices perform a good massage of the marginal periodontium, thus stimulating blood circulation at this level as well as increasing the rate of epithelial keratinization [14] of the percentage of those with a GDP below 0.3, so a continuous reduction of gingival inflammation. The only drawback was the high price of the electrical device, as well as the higher cost of the active heads that must be changed every 3 months. The vast majority of patients also mentioned that the method does not lead to accidental damage to the mucosa by sliding the brush and is just as easy and safe to use regardless of the patient's degree of fatigue. The electric brushing variant enjoys a greater receptivity and acceptance from the patients, the only obstacle being the price still increased but in continuous decrease of these devices. Further studies by Danser et al. [15] highlights the fact that a major element that makes one method or another of brushing to be accepted and applied in time by the patient is the ease of learning and performing the technique correctly. From the point of view of electric brushing, it helps most patients, being easy to

perform by the fact that the electric mechanism impresses on the rotating head the efficient brushing movement of the teeth and gums. The pressure sensor as well as the electric brush timer led to an optimal brushing time and to avoid damaging the marginal periodontium by overpressure [16-17].

At the end of the clinical trial, we can state that there were clear differences between the efficiency of electric and manual brushing. One explanation for these results is that the easy technique of the electric sanitizing variant leads to a maintenance of the technique unaltered over time, which in the case of manual brushing cannot be verified.

## CONCLUSIONS

Many of the patients who come to the dentist's office use an untimely technique that often leads to trauma to the marginal periodontium. The efficiency of any type of scientific brushing is much reduced if the patient is not motivated in advance. The classic Bass brushing technique has a lower efficiency compared to the electrically operated method while the acceptability of the electric brush is much higher among patients because learning to use it correctly does not raise any difficulties. The presence of the timer as well as the overpressure sensor eliminates the risk of damaging the marginal periodontium.

We conclude that the electric brush has a superior effect to the classical methods in terms of reducing gingival inflammation.

## REFERENCES

- 1 Daniel SJ, Harfst SA – Mosbys dental hygiene concepts. St.Louis Missouri. Mosby,2002.
- 2 Digel I, Kern I, Geenen EM, Akimbekov N. Dent J (Basel). 2020;8(1):28.
- 3 Ccahuana-Vasquez RA, Adam R, Conde E, Grender JM, Cunningham P, Goyal CR, Qaqish. J.Int J Dent Hyg. 2019 ;17(2):153-160.
- 4 Klonowicz D, Czerwinska M, Sirvent A, Gatignol JP. BMC Oral Health. 2018;18(1):185.
- 5 Waldron C, Nunn J, Mac Giolla Phadraig C, Comiskey C, Guerin S, van Harten MT, Donnelly-Swift E, Clarke MJ. Cochrane Database Syst Rev. 2019 May 31;5(5):CD012628.
- 6 Bucur SM, Iantovics LB, Bud A, Bud ES, Cocoş DI, Vlasa A. Retrospective Study Regarding Orthodontic Retention Complications in Clinical Practice. Applied Sciences. 2022; 12(1):273.
- 7 Bucur SM, Chiarati CR, Avino P, Migliorino I, Cocoş DI, Bud ES, Bud A, Vlasa A. Retrospective Study Regarding the Status of the Superficial Marginal Periodontium in Adult Patients Wearing Orthodontic Retainers. Romanian J Oral Rehabil. 2021; 13(2):194-201.
- 8 Ainamo J.- Assessment of the effect of an rotating toothbrush on oral health J.Clin.Periodontol.1996;5: 467-469.
- 9 Beals D. - A model to evaluate the relative cleaning effectiveness of toothbrushes. J Dent Res.2002;77: abstr.687.
- 10 Al Wahandi A,Khaled M,Kawamura M – Differences in self-reported oral health behaviour between dental students and dental hygiene students. J Oral Science. 2004;46:191-197.
- 11 Wolf HF, Hassel MT. - Color Atlas of Dental Hygiene. Thieme Publishing. London,UK, 2006 pp.153-178.
- 12 Hanioka T, Tanaka M.-Study of the effectiveness of an electric toothbrush. 42 Congress of Japan Dental Health, 1993.
- 13 Doherty F, Jaccobs M.- Plaque removal efficacy of an advanced toothbrush. Oral-B Laboratories Belmont, California;2003.
- 14 Ernst CP, Nauth C. – Clinical plaque removing efficacy of a new power toothbrush. Department of Restorative Dentistry and Periodontology Gutenberg University, Mainz. 2002.
- 15 Danser M, Timmerman M. – Efficacy of a manual toothbrush compared to electric toothbrush. Dept. Periodontology, ACTA Netherlands; 2002
- 16 Hellwig E, Klimek J.- Einfuhrung in die Zahnerhaltungskunde Ed.Urban & Schwarzenberg Munchen; 1995:353-355.
- 17 Korperich E. Maiwald HJ. - Grundlagen de Zahnheilkunde. Spitta Publishing, Balingen, Germany, 2003: pp 12-19.