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Comparison of Manual and Electric Toothbrush in Dental Plaque Removal: A Clinical Trial

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Background: Mechanical oral hygiene procedures are the most effective means of plaque removal and toothbrush is the most commonly used tool for mechanical plaque removal worldwide. There is an array of available manual and electric toothbrushes in the market. Thus, choosing the best one for dental plaque removal can be of great help for patients.
Objectives: This study aimed at compare the efficacy of dental plaque removal using a manual and an electric toothbrush.
Materials and Methods: This experimental, single-blinded sequential clinical trial was conducted on 12 patients (ten females and two males) who aged 21 to 30 years old. The tested manual toothbrush was 35-mm soft Oral-B Pulsar and the electric one was Oral-B Professional Care 8500 DLX chargeable D18. Patients' dental plaque score was set as zero through scaling, root planning, and polishing. Subjects were avoided tooth cleaning for three days and on day four, plaque accumulation was assessed using Tureskey's modification of Quigley and Hein plaque index.
Results: The mean of plaque index was 2.13 ± 0.83 and 2.11 ± 1.01 in the manual and electric toothbrush groups, respectively. No significant difference was detected between the study toothbrushes in terms of plaque removal (P = 0.374); however, with the manual tooth brushing, plaque removal was significantly greater in the buccal than in lingual surface and in the maxilla than in the mandible (P = 0.03 and P = 0.015, respectively).
Conclusions: Similar to previous studies, this study could not show the superiority of electric toothbrush over manual in plaque removal. After 72 hours, the mean of plaque index was greater in buccal than in lingual surface, which may be attributed to the natural cleansing action of the tongue.

Keywords: Dental Plaque; Plaque Index; Oral Hygiene

1. Background

Plaque-induced gingivitis is the result of an interaction between plaque microorganisms and host responses. According to the literature, more than 90% of people regardless of their age or gender are affected by plaque-induced gingivitis (1), which highlights the role of microbial plaque as the main and primary cause of periodontal diseases. Mechanical plaque control is the most effective method for preventing periodontal disease and dental caries (1-6).

Plaque control is defined as plaque removal on a routine daily basis and preventing its re-accumulation on tooth surfaces (1). Dental plaque is mainly comprised of bacteria in salivary glycoprotein matrix and extracellular polysaccharides. One gram of the plaque (wet weight) contains approximately 10^{11} bacteria. Plaque matrix prevents its removal through washing. Thus, use of mechanical tools is the most effective plaque removal method (1). Daily tooth brushing along with the use of other adjuvant methods is the most reliable method for maintaining oral hygiene (1, 7). A wide array of toothbrushes is available in the market, which differs in size, design, length, hardness, and arrangement of bristles; however, an ideal toothbrush is the one that efficiently eliminates microbial plaque (8). Since the introduction of electric toothbrushes into the market, their efficacy in plaque removal has always been a matter of discussion and debate (9, 10). Some manufacturers claim that their products are more capable of plaque removal (1, 11).

Studies have demonstrated that under controlled conditions and accurate supervision, well-trained individuals were able to remove all the visible plaque; but the majorities of subjects usually fail to do so (12). The mean duration of daily-spent time for tooth cleaning is less than two minutes, which results in removal of only 4% of the accumulated plaque. Several studies have reported improved plaque removal and subsequent periodontal

health by increasing the number of brushings to two times a day (1).

McCracken et al. compared plaque removal with a rotating powered toothbrush and a manual one in patients with chronic periodontitis. After 16-month study period, patients in two groups had no significant difference in plaque index or probing depth; however, the manual toothbrush was significantly different than the powered one in terms of decreasing bleeding (13). Mantokoudis et al. compared manual and electric toothbrushes and found no statistically significant difference between them in terms of plaque removal or tooth abrasion (14). Lazarescu et al. compared the efficacy of plaque removal by a powered and a manual toothbrush during an 18-week period and found that powered toothbrush had a significantly higher efficacy in plaque removal and improving gingival health in first time users of electric toothbrush. They also mentioned a significantly more pronounced learning effect with the electric toothbrush (15). Both toothbrushes, which were focused on through our study, have recently dominated the Iranian market as several other Oral-B products. It would be noteworthy to mention that no domestic or international study has compared the efficacy of these two products (Oral-B Soft Pulsar and Oral-B Professional Care 8500 DLX Chargeable D18) individually to each other yet. Introducing the most efficient methods and devices that is supported by evidence-based facts can be a great help for both patients and dentists.

2. Objectives

We aimed to compare plaque removal by manual 35-mm Oral-B Pulsar toothbrush and Oral-B Professional Care 8500 DLX Chargeable D18 electric toothbrush.

3. Materials and Methods

This comparative, interventional, single-blinded, cross-matched sequential clinical trial was conducted on 12 patients with a mean age of 24 ± 1.8 years (Range, 21-30). Subjects were selected among students of Guillan University who did not have any of the exclusion criteria. The exclusion criteria were presence of any systemic disease, periodontitis, gingivitis, or gingival hypertrophy, tobacco consumption, dental prosthesis or orthodontic appliances, or presence of dentofacial discrepancies that might affect the mechanical application of toothbrush on tooth surfaces. After clinical and radiographic examination and ensuring the presence of a healthy periodontium, all patients provided written informed consent and data were recorded in a designed questionnaire. At day zero (initiation of the study), the patients received complete scaling and tooth cleaning, their plaque index was reduced to zero and evaluated with the use of GUM plaque disclosing tablets, Tureskey's modification of Quigley, and Hein plaque index. For further precision, only buccal and lingual surfaces of teeth were assessed. Patients were asked not to use any mechanical or chemical method (not even water pressure) for microbial plaque removal for three days. On day fourth day, plaque index was assessed in the four quadrants starting from the lateral incisor to the third molar. The four quadrants were divided into two sides of right and left and each quadrant was cleaned by the operator (a periodontist) with one of the understudy moist toothbrushes without any toothpaste for 30 seconds (15 seconds for buccal and 15 seconds fir lingual surfaces). Modified Bass technique was used for the manual tooth brushing while the powered toothbrush had an oscillating/rotating movement. The operator was not aware of the type of toothbrush used and this data was recorded in a separate sheet and kept until the analysis. The manual toothbrush used was Oral-B Soft Pulsar and the electric toothbrush was Oral-B Professional Care 8500 DLX Chargeable D18. Each toothbrush was randomly used for the right or left side of the mouth in each patient. Plaque accumulation in subjects was re-assessed by the operator using Tureskey's modification of Quigley and Hein plaque index. The central incisors were not included in this study due to the potential coverage of the effect of toothbrush used for the opposite site on this area. Third molars were not included either due to the difficulty in measuring their plaque index. Obtained data were statistically analyzed using SPSS version 10 (SPSS Inc., Chicago, IL, USA) and student t-test was employed to compare results.

4. Results

A total of 12 patients including ten females and two males with a mean age of 24 ± 1.8 years (range, 21-30) were evaluated. The mean of plaque index was 2.13 ± 0.83 with manual 35-mm Oral-B Pulsar soft toothbrush and 2.11 ± 1.01 with the Oral-B Professional Care 8500 DLX Chargeable D18 electric toothbrush. Independent-samples t-test failed to find any significant difference regarding plaque index in the buccal and lingual surfaces of teeth between the study groups (P = 0.678 and P = 0.525, respectively). Furthermore, t-test failed to detect a significant difference in total amount of plaque index at the buccal and lingual surfaces of teeth between the study groups (P = 0.971). The difference between the study groups regarding plaque index in maxilla as well as mandible was insignificant, (P = 0.585 and P = 0.542, respectively). With regard to plaque index, the anterior as well as posterior teeth did not show any significant difference between the study groups (P = 0.976 and P = 0.975, respectively).

The teeth in the right as well as the left quadrants showed no difference in plaque index between the study groups (P = 0.572 and P = 0.626, respectively). No significant difference in the plaque index of the anterior and posterior teeth of each patient was found (paired t-test, P = 0.645 for the manual and P = 0.645 for the electric toothbrush). A significant difference was found in the plaque index between the buccal and lingual surfaces of teeth in the manual tooth brushing group (paired t-test, P = 0.015); however, such a difference was not found in the electric

tooth brushing group (paired t-test, P = 0.246). In addition, a statistically significant difference in the plaque index between maxillary and mandibular teeth in the manual tooth brushing group was seen (paired t-test, P = 0.03); such a difference was not found in the electric toothbrush group (paired t-test, P = 0.559). No significant difference was revealed in plaque index between the right and left sides in any of study groups. Plaque index values before and after tooth brushing were significantly different in both groups (paired t-test, P = 0.0001 in both groups).

5. Discussion

This study compared professional plaque removal by manual and powered toothbrushes in 12 subjects during a four-day period. Obtained results revealed that the study toothbrushes had no difference in plaque removal. Plaque index significantly decreased following tooth brushing in both groups. In manual tooth brushing, significant differences were detected in plaque removal between buccal and lingual surfaces as well as between maxillary and mandibular teeth; however, such a difference was not detected in the powered toothbrush group. This difference might be due to the presence of anatomic limitations in the lingual aspect like the tongue, better accessibility of buccal surfaces, and expertise of the operator in microbial plaque removal with a manual toothbrush. On the other hand, the powered toothbrush removes plaque through the automated oscillatory movement of its head and independent of the hand movement; thus, it causes no difference in plaque removal at the buccal or lingual surfaces. After 72 hours of not using any oral hygiene method, the mean of plaque index at the buccal and lingual surfaces of the teeth had an increasing trend from the anterior to the posterior and the highest plaque accumulation was seen in the first molar teeth in most quadrants. The highest mean plaque index before tooth brushing was found in the buccal surface of teeth in the left maxillary quadrant while the lowest rate belonged to the palatal surface of teeth in the left maxillary quadrant. In general, the mean plaque index was higher in buccal surfaces in comparison to the lingual surfaces after 72 hours, which might be due to the cleansing action of tongue movements on tooth surfaces.

In a review study by Robinson et al. in 2009, 42 studies were evaluated regarding powered and manual toothbrushes use and no significant difference was found in plaque removal between the powered toothbrushes with counter oscillation, side-to-side, circular ultrasonic or ionic movements, and manual toothbrush. In short term, however, powered toothbrushes with rotation oscillation movement acted more efficiently than manual toothbrushes (6). The results of the present study were in accord with the of Robinson et al. findings.

In a study by Renton-Harper et al., Braun-Oral B Plaque Remover types D5 and D6 powered toothbrush and manual 35-mm Oral-B toothbrush were compared. They reported no statistically significant difference between the assessed toothbrushes in terms of plaque reduction during their four-day study period, which is in accordance with the findings of the present study (16). Lazarescu et al. assessed the efficacy of plaque removal by Philips-Jordan Hp735 powered and Oral-B Indicator manual toothbrushes. They stated that the plaque index significantly decreased in both groups, which is also in agreement with our finding (15). Claydon et al. compared three electric toothbrushes with different head speeds. They demonstrated that all three could efficiently remove microbial plaque and were not significantly different in this respect. In addition, plaque accumulation in buccal surfaces was greater than in lingual ones. This study was similar to ours in terms of type of plaque index, tooth brushing by a professional operator, duration of oral hygiene withdrawal period, and the obtained results (17). Claydon et al. in another study compared eight different toothbrushes in terms of plaque removal efficiency and found no statistically significant difference between them, which is in agreement with our findings (18). van der Weijden et al. found no significant difference between the efficacy of an electrically active toothbrush and Butler manual toothbrush in overnight plaque removal and treatment of gingivitis (19). Danser et al. compared two oscillating/rotating powered toothbrushes in terms of efficient plaque removal and demonstrated that Oral-B Ultra Plaque Remover could remove dental plaque more effectively in comparison with Philips/Jordan hp 735 and this difference was more significant in proximal surfaces ($P < 0.01$) (20).

McCracken et al. evaluated the effect of force and duration of brushing with an electric toothbrush on plaque removal and demonstrated that both mentioned factors had a significant and direct correlation with the efficacy of plaque removal ($P < 0.001$). However, duration of 120 second and force > 150 gr had an insignificant effect on enhancing plaque removal (21). Claydon et al. evaluated the efficacy of three different toothbrushes in plaque removal in patients with gingival recession; they stated that plaque accumulation, and subsequently, plaque removal is different at different sites in the oral cavity and toothbrush design is not the only major variable affecting plaque removal; tooth surfaces also play a role in this regard (22). Biesbrock et al. evaluated a new manual toothbrush in terms of plaque removal efficacy. They compared Oral-B Exceed and Asian Colgate 360 and reported that Oral-B Exceed was significantly more efficacious in overall plaque removal than Asian Colgate ($P < 0.001$). In addition, Oral-B toothbrush could remove marginal and interproximal plaques more effectively than could Asian Colgate ($P < 0.001$) (23).

Warren et al. compared Braun Oral-B Plaque Remover (D7) powered toothbrush with a manual toothbrushes in terms of plaque control and reported than D7 was more efficient than the manual toothbrush, which might be due to the higher motivation in powered toothbrush users ($P < 0.05$) (24). In a review study, Niederman et al. compared

the efficacy of electric and manual toothbrushes and following evaluation of 290 articles, they concluded that electric toothbrushes were more effective than manual ones in terms of plaque reduction and control of gingivitis (25).

In a study by Heasman, lower plaque index was observed in powered toothbrush users in comparison with the manual toothbrush users; however, this difference was only significant at the interproximal surfaces ($P < 0.05$) (26). In this article, similar internationally approved methods of evaluation have been administered throughout the whole process, while comparing a manual toothbrush and an electric toothbrush from a common manufacturer. It might give the power to choose between a manual and electric device with a certainty that does not lay any weight to either side. Keeping in mind that the mean price and maintenance costs of these two products are obviously different, more research confirming this plaque-removal equality could be of a considerable help to dentists and attentively careful patients.

It is noteworthy that several recent studies have also obtained no evidence of a statistically significant difference between powered and manual brushes (27-30), while there are still new studies that find superiority with one type, which is mostly the electric type due to patient-selection and other specifically included criteria (31-33). This implies that further and longer trials would give greater power to systematic reviews of the efficacy of powered toothbrushes.

Based on the obtained results, powered and manual toothbrushes are equally efficient in dental plaque removal. It should be noted that regardless of the type of toothbrush, tooth brushing alone is not sufficient for plaque control and adjuvant cleaning devices like the dental floss are required. Tooth cleaning with manual or powered toothbrush should be done at least once a day. Dental plaque can accumulate within a few hours and therefore, it has to be removed regularly in order to prevent gingivitis, even in periodontally healthy subjects.

A similar study with a larger sample size and longer duration is recommended to obtain more accurate results. Gingival traumas following manual and powered tooth brushing also needs to be investigated in future studies. Assessment of plaque index at the interproximal surfaces following manual and powered tooth brushing and computerized analysis of the measurement and registry of plaque index due to its superiority over the clinical assessment are recommended.

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