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Comparison of Effectiveness of Manual and Electric Toothbrushes in Elimination of Dental Plaque and Gingivitis Reduction

Porównanie skuteczności manualnych i elektrycznych szczotek do zębów w eliminacji płytki nazębnej i objawów zapalenia dziąseł

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A – concept, B – data collection, C – statistics, D – data interpretation, E – writing/editing the text, F – compiling the bibliography

Abstract
The homeostasis of dental biofilm is essential for the maintenance of oral health. The most effective mechanical method of dental plaque control is tooth brushing. The effectiveness of this process depends on a number of factors, including type of toothbrush, brushing technique, motivation, time and frequency of hygiene procedures. Currently, many types of toothbrushes are available on the market. Over the last few years, beside various manual toothbrushes, electric tools are becoming increasingly popular. The aim of this paper was to provide an overview of the current available results concerning a comparison of the effectiveness of powered and manual toothbrushes in eliminating dental plaque and reducing gingivitis (Dent. Med. Probl. 2013, 50, 4, 467–471).

Key words: dental plaque, gingivitis, manual toothbrush, electric toothbrush.

Streszczenie

Słowa kluczowe: płyta nazębna, zapalenie dziąsło, szczoteczka ręczna, szczoteczka elektryczna.

The oral cavity is a specific ecosystem consisting of non-homogenous ecological niches. These zones are localized on dental surfaces, in gingival pockets, on the mucosal surface, and the surface of prosthetic restorations and orthodontic appliances where they become colonized by numerous microorganisms. They form spacial, organized structures defined as multispecies biofilm, comprising of bacteria, fungi and viruses encased in sugar polymers and protein matrix [1].

The application of advanced metagenomic methods has enabled the identification of almost one thousand species of microorganisms in the oral cavity. In the majority of cases they are commensal species which proliferate as a consequence of homeostasis, revealing their pathogenic characteristics or migrating and colonizing to other, atypical ecological niches. Oral microbiome is thus defined as mobile microbiome [2]. The disruption of microbiological balance and the metabolic
activity of dental plaque – specific biofilm localized on dental surfaces – are significant factors in the pathogenesis of the most prevalent oral disorders: caries and periodontopathy [3].

The effective control of dental plaque involves a variety of mechanical and chemical means of its elimination. Brushing is one of the basic, effective and universally accepted methods of teeth cleaning. The first manual (M) toothbrushes appeared about 3,500 thousand years BC and have undergone many modifications with regard to their shape and form. The notable breakthrough came with the replacement of natural bristle with nylon fibers, the introduction of wear indicators and ergonomic handles.

In the 1960s, models for electric toothbrushes were designed. Their development concerned the types of head movement, its frequency and the number of sweeps as well as the ability to monitor and verify the cleaning process.

On the basis of available literature, this study attempts to evaluate the effectiveness of manual and electric toothbrushes in the elimination of dental plaque and the reduction of gingival inflammation.

The electric toothbrushes available on the Polish market utilize three main technologies: oscillating/rotating/pulsating (ORP), which were created on the basis of modifications of oscillating/rotating (OR) technology, sonic (S) and ultrasonic (US). OR or ORP brushes do not require specific techniques or movements while brushing. The very application of the brush to the specific surface enables the removal of dental plaque. Sonic and ultrasonic brushes require technique recommended for manual brushes.

ORP heads move with 75–320 Hz frequency, performing 8000–40 000 sweeps per minute. The frequency of sonic brushes can reach 260 Hz, with 31 000 sweeps per minute. The ultrasound technology requires frequency in the range above 20 000 Hz with accompanying pulsation of 96 million rotations per minute. The most advanced models of electric toothbrushes also offer the choice of a working mode, brushing duration and application force [4].

A group of new generation brushes also include ionic brushes. The idea of its action is iontophoresis, electrophoresis, and electrolyzing, which are popular in other dental procedures [5]. The principle of this technique is based on altering the tooth surface charge by means of ionic exchange. This process inhibits bacteria adhesion to the pellicule structure and biofilm formation, and enhances plaque removal. Only limited data of short term studies is available in the literature concerning ionic toothbrushes. The comparisons are related to clinical effectiveness of sonic and ionic toothbrushes. Results of Singh et al. [5] and Van Swol et al. [6] reported a significant reduction in gingival index after ionic toothbrush usage, at the level comparable to sonic technology.

Deshmukh et al. [7] examined PII and GBI after 1, 2 and 3 weeks of ionic toothbrush using. Additionally, microbial assessment of dental plaque was done for detection of colony forming units (CFU). Study results revealed a significant reduction of PII and GBI index after ionic toothbrush application. In a short term study, the ionic technique was considered as a safe and effective technology. Due to the small number of available studies in this field, further comparative, long-term evaluations of ionic technology should be undertaken.

The debate on the effectiveness of manual and electric toothbrushes in eliminating dental plaque has been going on for years. The study by Baren et al. [8] carried out in 1993 demonstrated that a three-month application of oscillating and rotating brushes significantly reduces both the level of plaque and the manifestation of gingivitis. In the group of subjects using manual brushes such spectacular effects were not achieved. Similarly, Stoltze et al. [9] performed comparative studies based on GI evaluation on a group of patients who used a manual (M) or an electric (OR) toothbrush for a period of six weeks. They demonstrated that the percentage of the surface with visible plaque deposit was reduced to 9% and 30% in the OR and M groups, respectively. At the same time, the authors did not report any decrease in the GI parameter in the group of subjects using manual brushes whereas in the other group in question the mean GI showed a statistically significant decrease.

There have also been attempts to evaluate the use of a variety of toothbrushes in patients with chronic periodontitis. On the basis of a six-month observation, Haffajee et al. [10] concluded that in the group of patients using either manual or OR brushes there was a comparable, significant reduction of BOP and GI parameters with a concomitant improvement of the epithelial attachment level. Dentino et al. [11], continued comparative studies with regard to the effectiveness of various types of toothbrushes. Authors evaluated PII and calculus (CI), which refers to hard calcified deposit of inorganic salts, and is scored with four criteria. Study results demonstrated a significantly higher reduction of the plaque (PII) and calculus (CI) indices following the use of an OR brush. As for improvement in the epithelial attachment and elimination of staining, no differences were observed in either group.

Van der Weijden et al. [12–14], who published the results of their two-, six- and nine-month studies demonstrated that with the OR brush the
reduction of plaque levels and decrease of clinical parameters for gingival inflammatory conditions are more likely in comparison with a manual brush.

Haffajee et al. [15] demonstrated a statistically significant reduction of mean pocket depth, rate of bleeding and plaque index in persons using OR for three and six months, with the concomitant absence of improvement of GI or mean epithelial attachment in subjects using manual brushes.

In the recently published double-blind randomized trial, Jaina [16] confirmed that the plaque index after brushing for two and six weeks was statistically significantly lower in the group of patients using electric brushes than in the one using a manual brush.

There are reports in literature, however, which fail to confirm the superiority of powered brushes as opposed to the manual ones. In the studies by Dentino et al. [17], the effect of using OR or M brush on reducing symptoms of gingivitis is similar. These authors obtained a comparable drop in the modified gingival index (MGI) after three and six months of observation. The results of a sixteen-month study by McCracken et al. [18], in which these authors assessed the influence of using a powered and a manual brush on plaque levels, pocket depth and the bleeding index, also did not reveal differences in the levels of clinical parameters in both tested groups.

Such a discrepancy in the results presented in published reports prompted an independent group of experts acting on behalf of Cochrane Collaboration to verify the studies that aimed at determining the efficiency of oral hygiene practices when various types of toothbrushes are used. Based on that report, Heanue et al. [19] demonstrated that as far as electric brushes are concerned, the OR technology is the most effective in removing dental plaque and reducing manifestations of gingivitis. Subsequent analytic reports by Forest, Miller [20], and Deery et al. [21] confirmed that OR brushes are the most effective in eliminating dental plaque and resolving gingival inflammatory conditions.

Robinson et al. [22] performed another systematic review based on the report of Cochrane Oral Health Group – an independent group of experts. They analyzed the results of an audit of 244 papers concerning the performance of a variety of toothbrushes. The final analysis, which eventually covered 42 publications, demonstrated that OR brushes are more effective in eliminating gingivitis than the manual ones. These results were confirmed by both short- (1–3 months) and long-term studies (more than 3 months). The difference in the reduction of the GI and BOP parameters was 6% and 17%, respectively in favor of OR brushes.

Drisko’s [23] current review of literature confirmed that powered toothbrushes, especially those based on the OR technology, are decisively superior in reducing dental plaque and gingivitis. Their effectiveness is optimal when used in conjunction with dental flossing.

Providing the OR brushes with the pulsating module enhanced their cleaning performance especially in the proximal region which are generally inaccessible to bristles [24]. The effects of ORP technology in patients with gingivitis have been assessed in long-term, eight-month clinical trials, where there was a significant reduction of plaque levels and clinical parameters of gingivitis when compared with results obtained from the manual brush users [11]. Twelve-month observations of patients with gingivitis also showed a higher efficiency of the ORP brushes in supragingival plaque removal and improvement of the condition of the gums [25].

Rosema et al. [26] compared the effect of using the ORP and manual brushes in randomized clinical trials. After nine months of observations, higher reduction of plaque levels and a drop of the bleeding index were noted in the group of patients using powered brushes than in the users of manual brushes and dental floss.

The studies by Klukowska et al. [27] confirmed that in comparison with a manual brush, the ORP technology is three times more effective in reducing the symptoms of gingivitis, one and a half times more effective in reducing the bleeding index, twice as effective in reducing overall plaque levels, and five times more efficient in removing plaque from gingival margins.

In 2007, a new type of ORP brushes was launched on the market. They were additionally equipped with a cordless display. It enabled the monitoring the brushing activity including its duration for each quadrant and the pressure of the brush exerted on oral tissues. The idea behind this innovation was to increase the patient’s motivation and actively engage them in plaque removal. The preliminary reports evaluating the influence of this novel solution on brushing activity demonstrated that the Smart Guide system on average prolonged the mean brushing time by 39%, with concomitant reduction of time when too much pressure is applied by 89%. In consequence, 92% of subjects brushed their teeth more effectively [28].

The studies by Janusz et al. [29] demonstrated that the users of the ORP brush with display cleaned individual quadrants more thoroughly including the buccal and lingual surfaces. Increased motivation and monitoring of the cleaning process for 30 days consolidated proper oral hygiene habits. The cleaning effectiveness in users of identical brushes but without the option of display ver-
Significant differences in the reduction of plaque index (PIL) and bleeding on probing index (BOP), as well as the reduction of gingivitis in favor of the ORP brushes.

There are many publications which have demonstrated significant differences in the reduction of both the plaque index (PI) and the bleeding on probing index (BOP), as well as the reduction of gingivitis in favor of the ORP brushes. This review of literature makes it possible to conclude that electric brushes constitute a significant tool, worth recommending for the purpose of combating the infectious factor responsible for the progress of caries and periodontal diseases, due to their ability to effectively control dental plaque and reduce gingivitis. Safety usage of power toothbrushes includes selecting a soft-bristles brush head with end-rounded filaments and a dentifrice accepted by ADA, with RDA factor below 250. Despite a relatively high price when compared with manual brushes, electric toothbrushes offer a range of benefits and lower the cost of potential treatment of oral diseases, thus constituting a vital argument in promoting their widespread use.

**References**


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