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An Assessment of the Effect of Manual and Electric Toothbrushes on Hard and Soft Oral Tissue

Ocena wpływu ręcznych i elektrycznych szczotek do zębów na stan twardych i miękkich tkanek jamy ustnej

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

Abstract

In recent years a higher prevalence of gingival recession and dental abrasion has observed in the world population. The etiology of these pathological processes has a complex, multifactorial nature, but in many cases incorrect brushing techniques are recognized as one of the reasons for oral tissue destruction. Regular tooth brushing is the most important method of good oral care maintenance, but sometimes harmful effects to the dental and oral soft tissue structures are observed after forceful brushing procedures. Recently many new models of manual and electric toothbrushes are available on the market. The aim of this review is to present the current scientific views on the safety of soft and hard tissue with the use of various manual and electric toothbrushes (Dent. Med. Probl. 2013, 50, 4, 472–475).

Key words: gingival recession, dental abrasion, manual toothbrush, electric toothbrush.

Mechanical control of bacterial plaque is regarded as the key method of eliminating the infective agents responsible for the development of caries and gingivitis. A prerequisite for plaque removal is exerting enough energy on the biofilm. The energy generated has to overcome adhesion (adherence to the substrate) and cohesion (integration of the biofilm structure) [1]. In the case of manual toothbrushes this energy comes from the flexible bending and deflecting of the fibers, i.e. from physical abrasion. Electric toothbrush usage ensures an additional source of energy from hydrodynamic action and the generation of sound wave pressure. At present there are many models of mechanical toothbrush on the market, including oscillating-rotating toothbrushes (OR) and oscillating-rotating-pulsating toothbrushes (ORP).
It is assumed that efficient bacterial plaque removal can be accomplished by brushing the teeth for two minutes twice a day, using a fluoridated toothpaste [2]. However, patients tend to overestimate the time they spend on oral hygiene: Toothbrushing times below the recommended 2 minutes are observed, especially when no time control is conducted [3]. The pressure of the toothbrush head during toothbrushing seems to significantly affect the condition of the tissue in the oral cavity. According to some authors, manual toothbrushing entails the application of much higher pressure than the use of power brushes [4]. Toothbrushing techniques also affect the safety of oral cavity tissues to a significant extent. The horizontal scrub toothbrushing technique is still very popular in Poland, although it has been associated with an increased risk of inducing abrasive defects in oral cavity tissues, as compared to the rotary technique. Abrasivity also depends on toothpaste retention on the brush bristles. It is well recognized that toothpaste, which delivers many chemical agents, is an important factor in the prophylaxis of caries and gingivitis, but it also has some potential to do harm, connected with its abrasivity when the brush moves the paste over the tooth surface [5]. Some data indicate that soft-bristle brushes have more abrasive potential, because of better toothpaste retention on a smaller diameter, and due to flexible filaments that have better contact with dental tissue [5, 6]. On the other hand, when a proper toothbrushing technique is used, the type of toothpaste and its relative dentin abrasivity (RDA) value affect the abrasive potential more than the toothbrush bristle characteristics [7, 8].

The effectiveness of toothbrushing depends on:
– the frequency and duration of toothbrushing,
– the toothbrushing technique,
– the pressure applied to the tissue by means of a toothbrush,
– toothbrush bristle wear,
– manual dexterity and embedded habits,
– patient motivation to maintain optimal oral hygiene, and
– dental arch anatomy.

The authors of papers concerning the safety of different toothbrush types most often focus on a couple of aspects of this problem. They usually consider the toothbrushes’ efficiency in dental plaque removal, the effect that specific types of toothbrushes have on tooth hard tissue, and/or their potential to initiate abrasive damage and gingival recession.

The effect of the force used during toothbrushing on the efficiency of dental plaque removal was assessed in 1996 by van der Veijden et al. [9]. The authors compared the efficiency of toothbrushing by means of a manual brush and the oscillatory-rotary power brush Braun Oral-B Plak Control®. They also measured the habitual pressure generated during toothbrushing by means of manual and electric toothbrushes, using brushes with appropriate sensors. An analysis of the results allowed the authors to conclude that when using both manual toothbrushes and the power brush, increasing pressure by 100–250 g improves effectiveness of dental plaque removal. This effect was comparable on both buccal and lingual tooth surfaces. However, the percentage of plaque reduction, which corresponds to the effectiveness of oral hygiene procedures, was higher in the group using the Braun Oral-B Plak Control brush. Ultimate cleaning efficiency was achieved using a pressure of 300 g. Exceeding this threshold caused pain and gingival bleeding. The patients automatically applied lower pressure when using a power brush. Moreover, the force exerted on the lingual surfaces was higher than on the buccal surfaces.

Subsequent studies performed by van der Veijden’s group [10] complemented the previous findings. The authors documented a decrease in plaque removal efficiency from 60% to 56% when the pressure exerted by an electric toothbrush was increased from 1.5 to 3.5 N. An analysis of these results justifies the conclusion that an increase in pressure can favorably affect the efficiency of toothbrushing only to a certain extent. Exceeding the threshold of 300 g is not recommended due to the risk of tissue damage and a decrease in dental plaque elimination.

One of the parameters used to assess the influence of toothbrushing on tooth hard tissue is dentin abrasivity. Schemhorn et al. [11] have performed an experimental study to compare the RDA of manual and electric toothbrushes (the Braun Oral B Plaque Remover®) on neutron irradiated dentin. The study results showed that dentin abrasivity while using the electric toothbrush was very low (about 16 RDA) and that differed significantly from the abrasivity of a manual toothbrush (100 RDA). Since the electric toothbrush was proved not to increase dentin abrasivity it was determined to be safer for tooth hard tissue than manual toothbrushes.

Dörfer et al. [12] also affirmed the safety of electric brushes for tooth hard tissue in a long term study. The authors assessed the tooth surface profile by means of digital subtraction, using a 3D-Laser Scan Profiler after 35 months of brushing with oscillating-rotating-pulsating or manual toothbrushes. No statistically significant differences between the toothbrushes were observed in terms of the initiation of abrasive lesions within the enamel and dentin.

Danser et al. [13] assessed the development of gingival recession as a result of toothbrushing. The analysis they performed included the effects of the type of toothbrush, pressure, the frequency of head rotations and bristle shape on dental
plaque reduction and the risk of gingival recession. The authors observed no differences between manual and electric toothbrushes in the clinical parameters under investigation. Toothbrushes with sharp bristle ends increased the risk of potential gingival lesions as compared to the rounded ones. No correlation was found between gingival abrasion and the pressure exerted by the toothbrush head or the rotation speed.

Further studies in this area revealed that the additional option of pulsating movements utilized in oscillating-rotating-pulsating electric brushes, does not increase the risk of traumatic gingival injuries [14].

The safety of electric toothbrushes was also examined by Mantokoudis et al. [15]. They observed a group of 26 participants (dental students) who had received professional oral hygiene instructions for using both manual and electric toothbrushes. The effects of two different electric brushes (namely the Braun Oral-B Plak Control Ultra® and Braun Oral-B Plak Control 3D®) and a conventional manual toothbrush on plaque retention (Q-H plaque index), gingivitis (BOP index) and development or progression of gingival recessions was observed. The results demonstrated comparable efficiency of plaque removal by all the toothbrushes. No increased risk of gingival recession development was observed for electric toothbrushes.

In 2007 a new product was introduced to the market: a toothbrush that was developed to enable conscious control of toothbrushing. It created hope for an eventual increase in the efficiency of mechanical plaque control. This new type of toothbrush uses ORP technology and has also been equipped with an integrated wireless Smart Guide® display. It enables full control and monitoring of toothbrushing, including brushing time for each quadrant and toothbrush pressure on oral tissue. Too much pressure – exceeding 2N – is signaled by sensor excitation.

A 30-day comparative study was performed to compare the efficiency and safety of the new generation of toothbrush used with or without the Smart Guide® system [16]. In the group equipped with a display, the pressure sensor was excited 85% less often. In the group deprived of the possibility of monitoring their toothbrushing this reduction was only 53.4%. Using the Smart Guide® system also enabled participants to evenly allocate the time spent brushing each quadrant and specific tooth surfaces. A lack of brushing time control led to inadequate cleaning of lingual surfaces [16].

A systematic review was published in 2011 by van der Veijden et al. [17] concerning the safety of different toothbrushes in respect to soft and hard oral cavity tissue. Thirty five published reports from in vitro and in vivo studies culled from a number of databases were included in the report. Their analysis of the collected evidence enabled the authors to conclude that OR toothbrushes are safe and their usage does not lead to hard or soft tissue destruction.

An additional problem discussed as a result of incorrect toothbrushing techniques is the occurrence of tooth sensitivity [18]. Hypersensitivity can cause sharp temporary pain during hygiene procedures, eating or drinking. Some cases of hypersensitivity can be observed as a result of the caries process, or as a side effect of restoration or tooth bleaching. This pathology occurs when a loss of enamel or dentine, abraded by strong brushing force or eroded by highly acidic products, is observed. The exposure of dentinal tubules to the oral cavity environment causes a painful response to all kinds of stimuli. The most common surface for dentine hypersensitivity is the buccal-cervical area. From this point of view tooth sensitivity may be an indirect effect of an incorrect brushing technique, leading to gingival recession and dental tissue destruction. This damaging method of dental plaque elimination is frequent among manual toothbrush users. Power toothbrushes, especially working in OR mode, require less force for plaque removal than manual brushes [4]. Some in vitro studies have also indicated that brushing with low force could occlude patent dentin tubules through the formation of a smear layer [19]. Therefore, for tooth sensitivity prevention, a vigorous, excessive scrubbing technique with highly abrasive toothpaste should be avoided, especially immediately after drinking or eating acidic products. The application of desensitizing toothpaste and a proper toothbrushing technique with controlled toothbrush pressure is highly recommended as an important element in the treatment and prevention of hypersensitivity [20, 21]. The hypersensitivity mode available in modern type of electric toothbrush and appropriate brush heads with soft bristles make it possible to effectively eliminate hypersensitivity symptoms. To date, no studies have reported any increase in the risk of tooth sensitivity after using electric toothbrushes [22].

The results outlined above suggest that the proper use of power toothbrushes is safe for hard and soft oral tissues. Electric brushes do not increase gingival abrasion in comparison to manual toothbrushes. Dentin abrasivity was not found to be higher when using power brushes – conversely, they proved to be less abrasive than manual brushes. Taking into account the advantages of electric toothbrushes over manual ones in terms of dental plaque removal and the reduction of gingival inflammation, the use of electric brushes should be promoted in everyday oral hygiene routine as an important and effective way to prevent and treat many oral pathologies.
References


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