Plaque Removal Efficacy of Manual Tooth Brushing in Crowded Mandibular Frontal Teeth

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Abstract

The aim of the present in vivo study was to evaluate the efficacy of two different bristle stiffness, in plaque control of crowded mandibular teeth. To classify the patient mandibular frontal teeth irregularity, the quantitative Little´s Irregularity Index was used. To quantify the dental plaque accumulation, the Distal-Mesial Plaque Index (DMPI) was assessed by a single examiner. After each plaque accumulation period, which lasted for 24 hours, the plaque removal efficacy of a soft or medium stiff manual toothbrush were measured. The mean interproximal DMPI of the irregularity group with mild and moderate crowding was, prior to brushing with the soft bristle toothbrush, 1.87 on the facial surfaces, 1.93 on those of the lingual surfaces, and 1.90 on both the facial and lingual surfaces. The new mean interproximal DMPI after brushing of the facial teeth surfaces was 1.54. On the lingual surfaces an index of 1.58 and on the facial and lingual surfaces combined an index of 1.56 was measured. Considering the percentage of the remaining interdental plaque, on the severely crowded surfaces, the toothbrush with medium bristle stiffness was slightly, with two percent, more effective in removing interproximal plaque with a percentage of 23%, compared to the toothbrush with a soft bristle stiffness removing 21% of the interdental plaque. In conclusion, the manual toothbrush with round-ended medium stiffness bristles was slightly more effective in removing interproximal plaque compared to the toothbrush with round-ended soft bristle stiffness. In comparison, there was a slight difference interdental plaque removal between the soft and medium stiff round-ended toothbrushes, independently of the crowding degree.

Keywords: dental plaque, crowding, plaque control, oral microbiome

INTRODUCTION

A key component of dental education and health promotion initiatives has always been to promote effective plaque reduction through mechanical methods. There is no question that promoting frequent brushing has contributed, at least in part, to the reduction in periodontal and caries diseases. The patient's ability to regulate supragingival biofilm at home is the most crucial factor in achieving and preserving oral health. The most frequent regions for plaque to accumulate are the interproximal regions of the anterior and posterior teeth (1). A study on anterior crowding noted that crowding makes it more difficult to maintain adequate oral hygiene, and those patients with average oral hygiene were shown to have greater plaque retention (2). Since the most prominent, age-related physiologic change in the dentition is distinguished to be the crowding of the frontal teeth, especially the lower incisors, the efficient plaque removal in these hard to reach interproximal tooth areas is very important (3). For this reason, daily use of dental floss, an interdental brushe, and other interdental cleaning devices are advised. Nevertheless, these cleaning instruments are still uncommonly used and often only the toothbrush is utilized. Additionally, nowadays there are a variety of toothbrushes with various bristle stiffness and patterns flooding the market, each claiming to be more effective in removing plaque. Without any professional guidance, the common person may find it difficult to choose the right toothbrush because of this and frequently choose brushes based on price, accessibility, familiarity, and promotional claims (4). Furthermore a hard toothbrush, also called a firm-bristled brush, causes more soft tissue trauma, and it is because of this knowledge, increasingly difficult to find in stores (5).

According to one of the definitions, dental plaque is a particular but very changeable structural entity, composed of bacteria and their products, incorporated in a highly structured intercellular matrix. It is a representation of a true biofilm made up of various microorganisms engaged in a variety of molecular, metabolic, and physical interactions (6). Clinically, dental plaque has been described as the soft, tenacious substance that forms on the surfaces of teeth and is difficult to remove with simple water rinsing (7).

In general there are four stages in the process of microbial adhesion to surfaces in an aquatic environment. The initial transportation of bacteria to the tooth surface is the first stage. Contact could occur randomly by different molecular movements. In the second phase, the initial adhesion, a reversible adherence that is brought on by the interaction of long and short range forces between the bacterium and the surface at a given distance (50 nm).

After initial adhesion, particular interactions (covalent, ionic, or hydrogen bonding) after direct contact or by bridging real extracellular filamentous appendages create a firm attachment between bacteria and surface. In the last phase, microcolonies or a biofilm may form as a result of the increasing, firmly attached microorganisms and the continued attachment of the newly formed bacterial clusters (8).

On the teeth, with the number of those co-adhesion processes the microbial colonization and the development of biofilm is started (9).

The oral microbiome contains up to 750 different types of microbes, creating it a complex ecosystem (10). Aerobic (i.e. oxygen-tolerant) bacteria, including Neisseria and Rothia. are frequently the initial or primary colonists (10). The majority of the earliest colonizers are cocci, particularly streptococci, which make up between 47 and 85% of the cultivable cells discovered within the first four hours following a professional tooth cleaning (10).

Streptococcus mutans, Streptococcus sanguinis, and Streptococcus mitis make up the majority of the streptococci, while Streptococcus salivarius are often less common (11). Early

colonists alter the environment by their metabolism, such as by increasing the anaerobic state of the environment after they consume oxygen (12).

As oxygen level of plaque falls, gram-negative, anaerobic (i.e., oxygen-intolerant) species predominate in later plaque development stages and the subgingival plaque. However, there is proof that oxygen cannot reach the dental plaque deeper than 0.1 mm. With this, some of them, such Treponema, Porphyromonas, Prevotella, and Fusobacterium species, may also be seen in early plaque (10).

Since there can be a wide range in the composition of plaque microorganisms, the consequences of dental plaque affecting the oral health can largely vary.

The metabolism of dietary sugars through bacterial microorganisms creates an acidic accumulation in the dental plaque. When the pH of plaque decreases under der critical value of 5.5, hydroxyapatite becomes soluble and demineralization of enamel is initiated (13). Acid production, acid tolerance, and the formation of intracellular and extracellular polysaccharides are characteristics linked to cariogenicity that are not unique to one species. By building food chains with other plaque bacteria, like Veillonella species, which transform lactate into weaker acids, or by the creation of alkali by salivary components, acid production can be counteracted (12). In events, for instance of high sugar consumption or low salivary flow rate, there are proportionally only few acid- counteracting microorganisms the pH of the plaque rapidly decreases from 7.0 to below 4.5. With the continuous maintenance of such low pH, the balance of demineralization and remineralization is lost and the dissolution of the tooth structure creates carious cavitation (10). Therefore, regular plaque removal is mandatory to protect dental tisuues especially in hard to reach areas.

Aim and objectives

The aim of the present in vivo study was to evaluate the efficacy of two different bristle stiffness, namely soft and medium bristle stiffness, of a manual toothbrush. The final goal of this experimental study is to be able to recommend patients the right bristle hardness of a manual toothbrush that can be more effective in removing interproximal plaque from the lower anterior teeth, according to the patient's individual degree of crowding. Thus, the null hypotheses underlying the present study is that there is no different effect of tooth brushing in interproximal areas depending on the bristle stiffness, as determined by the plaque removal efficacy.

MATERIAL AND METHODS

This interventional study was performed during July – September 2023 on a sample of 25 randomly selected patients who underwent following inclusion criteria:

1. Presence of all natural six permanent mandibular frontal teeth
2. Good general health
3. Affiliation to one of the Little´s Irregularity Index Classification

Exclusion criteria were represented by the presence of orthodontic appliances or retainers on the mandibular teeth, prosthetic devices and the presence of large plaque retaining cavities on mandibular frontal teeth.

To classify the patient mandibular frontal teeth irregularity, the quantitative Little´s Irregularity Index was used. According to this system, measurements straight from the mandibular arch have been taken while holding a caliper (Fig. 1) parallel to the occlusal plane. Thereby, the linear displacement of the neighboring anatomic contact points of the mandibular incisors was calculated and the sum of the five measurements represented the case´s Irregularity Index value (14).

Using the criteria shown in table 1, each subject was evaluated subjectively on a scale from 0 to 10.

Table 1. Little´s Irregularity Index (14)

Degree of Irregularity (mm)	Little´s Irregularity Index
0	Perfect alignment
1-3	Minimal irregularity
4-6	Moderate irregularity
7-9	Severe irregularity
10	Very severe irregularity

Each patient was then assigned to one of three main groups with 1 - no crowding, 2 - minimal and moderate crowding, 3 - severe and very severe crowding. In this way, it was later possible to compare the extent to which the interproximal plaque of the three main groups could be removed more or less effectively with the respective bristle hardness of the toothbrush.

To start with the same plaque accumulation preconditions, the selected subjects received a professional tooth cleaning, by brushing their teeth with a slow speed hand piece, ultrasonic scaling and interdental flossing. The patients were then instructed to discontinue their daily oral hygiene measures on the mandibular frontal teeth.

After each plaque accumulation period, which lasted for 24 hours, the plaque removal efficacy of a soft or medium stiff manual toothbrush were measured. Thereby the starting bristle stiffness of the toothbrush were randomly selected and both, the patient as well as the examiner were blind to the identity of the toothbrush bristle stiffness. To insure the original bristle stiffness, the brush was disposed of after each single use.

To begin with, the patient was instructed to thoroughly rinse his mouth to remove of all food particles and thick saliva. Hereafter, dental plaque was disclosed with plaque revelator (Mira- 2- tone, Hager Werken) by direct application with impregnated single use appliers on the lower frontal teeth. The subject was then asked to rinse again with tap water immediately after the application of the plaque disclosing agent. The older and thicker accumulated plaque was then visualized as blue and the newer and thinner plaque as red or pink color.

To quantify the dental plaque accumulation, the Distal-Mesial Plaque Index (DMPI) was assessed by a single examiner. Plaque accumulation on each of the interproximal areas (Fig. 1), naming the areas disto-occlusal (DO); disto-middle (DM); disto- gingival (DG), as well as the mesio-occlusal (MO); mesio-middle (MM) and mesio-gingival (MG), were scored (Tab. 2) on the lingual as well as on the labial tooth surface.

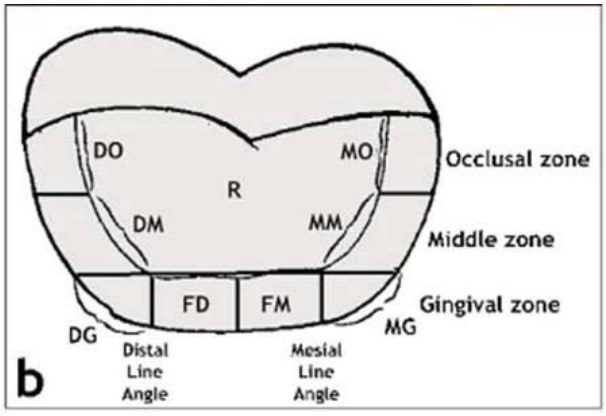

Figure 1. The DMPI zones (15)

Table 2. Numerical values of the DMPI (15)

0	**No plaque present**
1	1/3 of the area covered by plaque
2	2/3 of the area covered by plaque
3	Complete area covered by plaque

After grading each of the six lower frontal teeth, from canine to canine, a mean plaque score of each tooth was calculated and noted down. Photos of the stained teeth were taken for the documentation. Next, the manual toothbrush, with for the examiner unknown bristle stiffness, was immersed into tap water for 75 seconds and afterward, the toothbrush was taped twice against the water glass to remove excessive water. One trained right-handed examiner, standing on the right side of the patient, brushed the lower frontal teeth of the patient with equal force and in absence of a dentifrice. In order to obtain excellent plaque reduction with a concurrent protection of the oral tissues against mechanical irritation, the modified Bass technique is frequently advised for manual tooth brushing. First, the orientation of the toothbrush head was oblique and apically directed, causing the bristles to make a 45-degree angle with the tooth axis. Because of this angle, the tips of some bristles got slightly inserted into the gingival sulcus while others filaments brushed the gingival margin. Within the sulcus, back and forth motions with small horizontal amplitudes were used. The bristles could then enter the interproximal gaps with a stronger pressure. After those movements, the toothbrush head was rotated in an occlusal direction, from the gingival tissue to the tooth surface, to wipe out debris. Although the toothbrush was positioned vertically at the level of the lingual surfaces of the anterior teeth, the movements were the same on the lingual surfaces (16,17).

With the general recommendation for a brushing time of minimum 2 minutes for the whole dentition in both arches (18), the calculated brushing duration for the lower frontal teeth segment amounts 20 seconds. Dividing those 20 seconds for all six lower frontal teeth, the brushing time results in 10 seconds for the labial as well as 10 seconds for the lingual surfaces.

Following the tooth brushing, again the plaque was visualized by using the plaque disclosing agent Mira- 2- tone dye and the stained plaque was reexamined according to the DMPI plaque interproximal areas. Once again, intraoral photos were taken for documentation.

At the end of the study, the mean DMPI before and after tooth brushing as well as the efficiency to remove the interproximal plaque of the respective toothbrush bristle stiffness were calculated and compared with the collected data.

RESULTS

In order to quantify the interproximal plaque removal efficacy, the under mentioned diagram (Fig. 2) shows the mean interproximal DMPI of the irregularity group of no crowding before and after tooth brushing, with particular respect to percentage of the remaining dental plaque after tooth brushing with a soft bristle hardness toothbrush.

Before tooth brushing, the mean interproximal DMPI revealed on the facial teeth surfaces 1.79, on the lingual teeth surfaces 1.20 and summed on the facial as well as the lingual teeth surfaces of 1.49. In comparison with the mean interproximal DMPI of the facial teeth surfaces with 1.48, the remaining plaque after tooth brushing revealed 82%, the lingual surfaces with 1.03 manifested 86% and in combination of the facial and lingual surfaces 1.25 DMPI, the remaining interproximal plaque after tooth brushing evidenced 84%.

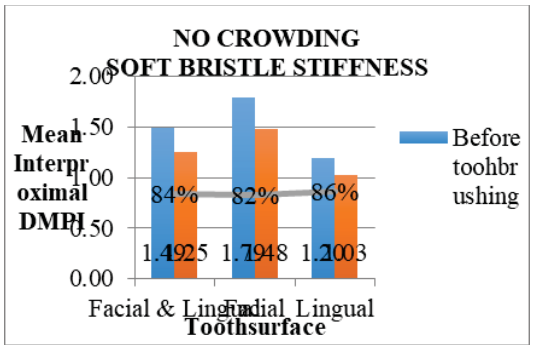

Figure 2. No crowding irregularity: Mean interproximal DMPI with the soft bristle stiffness toothbrush

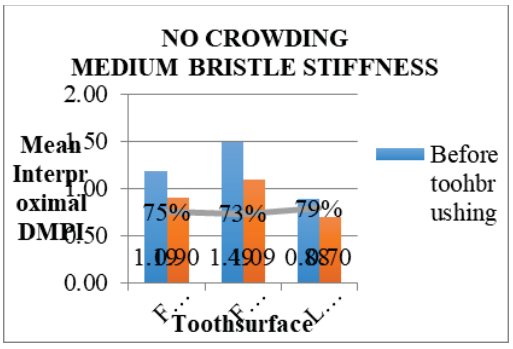

Figure 3. No crowding irregularity: Mean interproximal DMPI with the medium bristle stiffness toothbrush

The same irregularity group without crowding showed the following results with regard to the medium bristle stiffness toothbrush (Fig. 10). Before using the medium bristle toothbrush, the mean interproximal plaque DMPI on the facial tooth surfaces counted 1.49, 0.88 on the lingual tooth surfaces, and 1.19 when the facial and lingual surfaces were added together. The interproximal plaque that was still present after brushing was 73% in relation to the remaining mean interproximal DMPI of the facial tooth surfaces, which is 1.09. On the lingual surface, there was has a mean interproximal DMPI after tooth brushing of 0.70 and the combination of the facial and lingual surfaces, showed a mean interproximal DMPI after tooth brushing of 0.90. With this outcomes, the percentages of the remaining dental plaque after brushing revealed 79% on the lingual tooth surface and 75% on both surfaces together.

The comparison of this case demonstrates that the medium bristles of a toothbrush were more effective, facial and lingual surfaces with a total of 25%, in removing the given interproximal dental plaque without accessory auxiliary interdental cleaning devices than the medium bristle toothbrush, facial and lingual surfaces together with a total of 16% (Fig. 4).

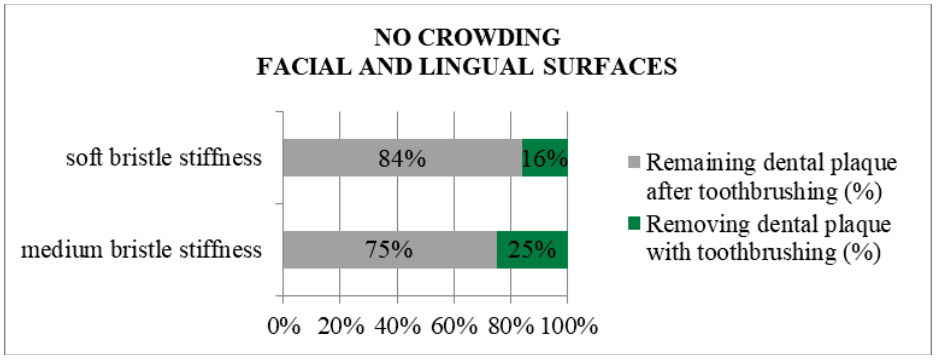

Figure 4. Comparison soft and medium bristle stiffness – no crowding

The mean interproximal DMPI of the irregularity group with mild and moderate crowding is shown in the diagram below (Fig. 5).

Prior to brushing with the soft bristle toothbrush, the mean interproximal DMPI was 1.87 on the facial surfaces, 1.93 on those of the lingual surfaces, and 1.90 on both the facial and lingual surfaces.

The new mean interproximal DMPI after brushing of the facial teeth surfaces was 1.54. On the lingual surfaces an index of 1.58 and on the facial and lingual surfaces combined an index of 1.56 was measured. The percentages of plaque left over with the soft bristle toothbrush counted 82% on both the facial, the lingual surfaces. With those results, in

combination of these two surfaces, the total remaining dental plaque after tooth brushing listed as well 82%.

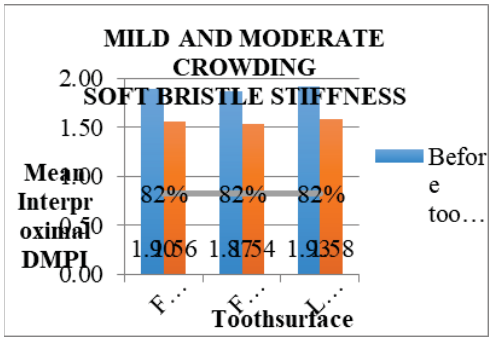

Figure 5. Mild and moderate crowding irregularity: Mean interproximal DMPI with the soft bristle stiffness toothbrush

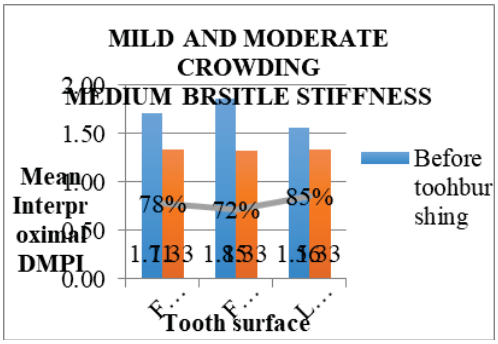

Figure 6. Mild and moderate crowding irregularity: Mean interproximal DMPI with the medium bristle stiffness toothbrush

Figure 6 shows the data of irregularity group of mild and moderate crowding in consideration with the medium bristle stiffness toothbrush.

Regarding the mean interproximal DMPI on the facial tooth surfaces, it numbered 1.85 before and 1.33 after tooth brushing, which resulted in a remaining plaque of 72%. On the lingual surface after the plaque accumulation, it showed a mean DMPI value of 1.56 and after brushing 1.33, giving a percentage of 85 remaining interproximal dental plaque. The two surfaces together displayed before tooth brushing a value of 1.71 and afterward a value of 1.33, resulting in a total amount of 78% remaining dental plaque with the medium bristle toothbrush.

Comparing the data of this irregularity group with the soft and medium toothbrushes, it could be concluded that the medium toothbrush removed a slightly greater amount of plaque with a efficacy of removing the interproximal plaque with 22% compared to the 18% with the soft toothbrush (Fig. 7).

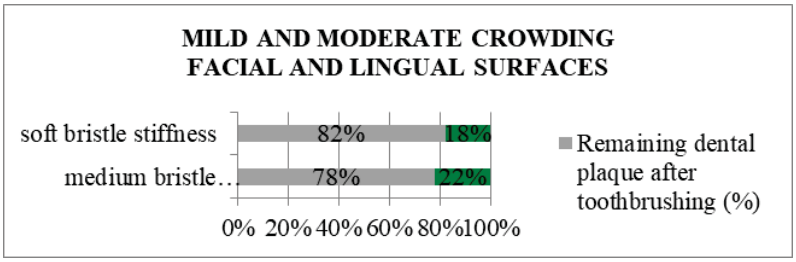

Figure 7. Comparison soft and medium bristle stiffness – Mild and moderate crowding

The data of the severe and very severe crowding irregularity group in reference to the mean interproximal DMPI are outlined in the two following charts.

Figure 8 illustrates the information regarding the soft bristle toothbrush. On the facial surfaces of the six lower frontal teeth a mean interproximal DMPI was measured with initially 1.89 and 1.44 afterward. The remaining dental plaque after brushing counted 76%. The lingual surfaces revealed an incipient index of 1.78 and subsequent index of 1.46. According to these facts, a percentage of 82 of plaque remained right after the brushing. Both, the facial in addition with the lingual surfaces, yield in a mean DMPI of 1.83 prior and 1.45 after brushing the teeth. With this, the persisting interdental plaque accounted for both areas 79%.

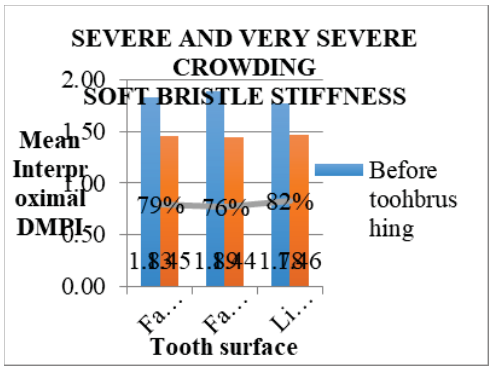

Figure 8. Severe and very severe crowding irregularity: Mean interproximal DMPI with the soft bristle stiffness toothbrush

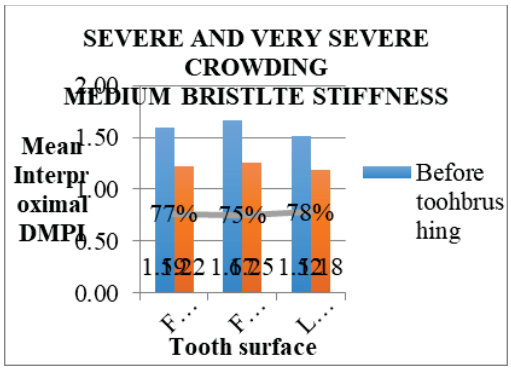

Figure 9. Severe and very severe crowding irregularity: Mean interproximal DMPI with the medium bristle stiffness toothbrush

Information regarding the mean interdental DMPI with a medium bristle tooth brushing in the group of severe and very severe crowded lower frontal teeth is presented in Figure 16. Before tooth brushing the mean interproximal DMPI of the facial, 1.67 and the lingual surfaces, 1.52, added up together to an index of 1.59. After tooth brushing the mean interdental DMPI of the facial, 1.25, and the lingual surfaces, 1.18, resulted combined in an in the mean DMPI of 1.22. The remaining dental plaque after tooth brushing showed a percentage of 77 for both surfaces together, 75% for only the facial, and 78% for just the lingual surfaces.

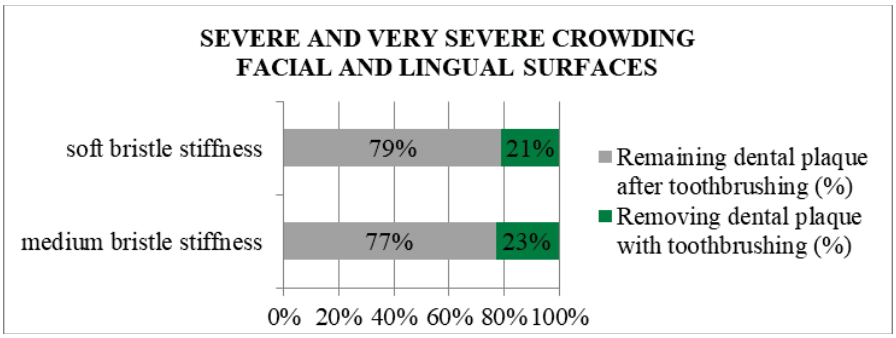

Figure 10. Comparison of soft and medium bristle stiffness – Severe and very severe crowding

Considering the percentage of the remaining interdental plaque, the toothbrush with medium bristle stiffness was slightly, with two percent, more effective in removing interproximal plaque with a percentage of 23%, compared to the toothbrush with a soft bristle stiffness removing 21% of the interdental plaque (Fig.10).

DISCUSSIONS

The purpose of this clinical study was to survey the efficacy of manual toothbrushes with different bristle stiffness, soft and medium hardness, to achieve oral hygiene in terms of interproximal plaque removal capacity without additional interdental cleaning measurements.

The evaluation was based on the DMPI of patients with different Little´s irregularity indices after a plaque accumulation period of 24 hours and after tooth brushing with the respective bristle rigidity.

The DMPI was chosen due to its ability to precisely measure which bristle hardness is more effective in removing interproximal plaque from individual tooth surfaces.

The advantage of this index is that it was possible to determine very precisely how much the bristles of the toothbrush could remove the plaque in the interproximal area.

On the contrary, due to the high specificity of this index, the evaluation was time-consuming and the possibility of introducing mistakes was higher. Trained examiners should therefore only use it.

To circumvent possible errors regarding the accuracy of the real plaque amount, in the study by Otsuka et al., pictures were taken to document and measure the plaque clearance area, using a digital single-lens reflex camera for dental purposes. The number of pixels were analyzed by Adobe Photoshop CS5 Extended in each image and used to calculate the plaque removal area (19).

In other studies, which also investigated plaque removal capacity of toothbrushes in interproximal areas, the selected plaque indexes were not as specific to the particular areas of a tooth surface. Many studies, which investigated the interdental plaque removal efficacy of toothbrushes with different bristle stiffness, used the Quigley and Hein´s plaque index, the Rustogi modification of Navy plaque index as well as the Loe and Silness index, which are all less specific to the interproximal areas and therefore not as informative as the DMPI (1).

Referring to Zimmer et al., hard-bristled manual toothbrushes were found to be more effective at removing plaque from proximal surfaces as well as from free smooth surfaces than soft-bristled toothbrushes of the same type. This improved cleaning performance, though, was linked to more soft tissue abrasion. For the medium toothbrushes, the findings were in between (20,21).

According to findings like those, there are more toothbrushes with soft and medium bristles on the market, than hard-bristles toothbrushes. Through this fact, the toothbrush with hard bristle stiffness was not investigated and only the manual toothbrushes with medium and soft bristles were examined in this current study.

An in vitro study, published in 2019 and performed by Otsuka et al., investigated properties of commercially available manual toothbrushes influencing the plaque removal of interproximal surfaces. Experimental tooth plaque was reduced following the brushing test, however, each plaque removal rate was under 50%. Brushes with any bristle type, including the difference between soft and medium bristle stiffness, had difficulty in getting contact around the artificial tooth. It was discovered by using mixed effect modeling to analyze the data, that the variations, like the bristle hardness, the number of tufts, and the length, all affect the plaque removal rate from interproximal surfaces (19).

According to the findings in the in vivo study of Zanatta et al., medium toothbrushes effectively eliminated more dental biofilm than soft toothbrushes, regardless of whether toothpaste or not was used (22).

Additionally, Rosema et al. as well as Caporossi et al., stated that the presence or absence of toothpaste had no impact on the plaque removal (23).

On the other hand, Keller et al. stated, that a toothbrush with toothpaste was much more efficient in plaque removal than using only water during tooth brushing (24).

Since there are various measurements here, it would also be useful to compare the different bristle stiffness with and without toothpaste.

Since the previous studies examined the plaque removal efficacy of manual toothbrushes with different bristle hardness for patients considering all present dentition areas, this current study focused especially on the crowding degree of patients, more specifically on the mandibular frontal teeth.

The results of the current study should be considered for recommendations of manual toothbrushes to patients with certain degrees of irregularities in the lower frontal teeth.

To give emphasis on the selected variable of the toothbrush, the bristle stiffness, all other parameters were kept constant e.g. toothbrush bristle design, toothbrush head shape, bristle arrangement and tooth brush brand.

In the present study, round-ended bristles and no dental dentifrice were used.

Caporossi et al. found out, that tapered filaments were less effective in plaque removing from tooth surfaces, inclusively the interproximal surfaces, compared to end-rounded filaments, regardless of with or without toothpaste was utilized. In contrast to this, Dorfer et al. found that in comparison to toothbrushes with end-rounded bristles, tapered brushes removed more plaque (23). Referring to the study of Cifcibasi et al., the bristle arrangement of a toothbrush had little impact in the role of plaque removal (25).

On the opposite side, in 2021 it has been concluded in a systematic review with meta-analysis, that in consideration of interproximal surfaces, tapered-tip bristle toothbrushes may produce superior outcomes than end-rounded bristle toothbrushes (1).

According to these different statements, further studies could take into account that there might be differences between soft and medium hard bristles with tapered bristle ends, which might give different results than with round ended ones.

For this study, the modified Bass tooth brushing technique was applied by a single, trained examiner, to assure constantly the same type of brushing movements and forces for all tests. This brushing technique was chosen for this current study since it was analyzed by Payato-Ferra et al., demonstrating that the modified Bass technique approach significantly outperformed conventional brushing techniques in eliminating supragingival plaque from both the buccal and lingual sites (26).

In other studies, like in the systemic review by Mueller-Bolla et al. it is stated that when a certain age of child, more precisely over 7 years of age, is reached, there would be no difference in tooth brushing techniques in terms of plaque removal (16).

It should be also considered, that nowadays more and more people are able to financially afford an electric toothbrush, which does not involve any particular brushing technique.

Once again, it would be recommended to combine the study of ideal bristle hardness for certain crowding degrees with other types of brushing techniques, as well as with an electric toothbrush, in order to figure out the most effective way of plaque removal without further additional interdental cleaning devices.

However, this study had several important limitations, which should be taken into account for further investigations in this specific field of research.

Due to the fact, that this study was an in vivo study, there were advantages and disadvantages. On the one hand, there were uncertain parameters, such as the patient compliance dependency, the dietary habits and the saliva composition. Those types of disadvantages can be excluded in vitro studies.

On the other hand, this study presented real dental plaque as well as real teeth and gingival tissue, which presented the real situation compared to in vitro studies.

To gain more distinct results, a greater amount of patient examinations, a longer time of plaque accumulation and defined eating habits would be necessary to improve the outcome.

This interventional study only focused on the irregularity degree of the lower frontal teeth.

An improvement of the study could be, to take into consideration the overall irregularity degree of patients, in order to be able to recommend patients the bristle stiffness of a toothbrush, which could remove more interproximal plaque compared to another bristle stiffness if the patient is not using additional interdental cleaning devices.

CONCLUSIONS

In conclusion, the manual toothbrush with round-ended medium stiffness bristles was slightly more effective in removing interproximal plaque compared to the toothbrush with round-ended soft bristle stiffness. In comparison, there was a slight difference interdental plaque removal between the soft and medium stiff round-ended toothbrushes, independently of the crowding degree. Thus, the original null hypothesis can be rejected. The greatest difference of plaque removal with the medium bristle stiffness of nine percent more than soft bristle stiffness was present in the group of no crowding. In the irregularity group of mild and moderate crowding, the medium bristle stiffness removed four percent more than the soft one and in the severe to very severe crowding degrees only two percent more.

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