REPORT

# IMPORTANCE OF INDIVIDUAL ORAL HYGIENE IN ORAL HEALTH MAINTENANCE: SCIENTIFIC LITERATURE REVIEW

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**Annotation**

*The aim of the study, based on scientific literature review, is to reason the importance of individual oral hygiene in prevention of oral diseases. Both the patient and dental professional should play an active role in controlling the plaque build-up by maintaining good oral hygiene. The best method for cleaning the oral spaces that are difficult to access must be defined for each patient individually. Efficient tooth brushing is the first step towards dental care and is a conveniently accessible dental device which helps prevent dental problems.*

*The significance of good oral hygiene in order to prevent oral diseases is indisputable. Evaluating individual needs and conditions and weighing them together with scientific support should be the basis for instructions and recommendations, thus creating the best possible foundation for patient compliance and long-lasting oral health.*

**Key words:** *individual oral hygiene, oral health maintenance.*

**Introduction**

Poor oral hygiene refers to presence of deposits in and around the gums and on teeth which lead to inflammation of gums causing gingivitis. Bad breath, bleeding gums and salty taste are symptoms of gum disease. When left untreated this eventually lead to periodontitis. Brushing is the most practiced oral hygiene method for plaque removal. Although the toothbrush is successful in removing plaque at the buccal, lingual, and occlusal surfaces, it can't completely remove plaque from the interproximal surfaces of adjacent teeth. These regions are protected against the natural cleaning mechanisms of the oral tissues; thus, emphasis should be placed on the importance of the devices used to facilitate oral hygiene in these areas. Different types of interdental cleaning aids that have been developed for this purpose include dental floss and tape, toothpicks, interdental and bottle brushes and water irrigation units. This wide range of commercially available interdental cleaning aids make various claims for their beneficial effects in terms of reduction in plaque scores and gingival inflammation [1].

Careful plaque removal techniques can modify both the quantity and the composition of the gingival plaque, changing the composition of the microbiota of the pocket and reducing the percentage of periodontal bacteria [2].

For patients with fixed orthodontic appliances it is particularly difficult to achieve good oral hygiene because the appliances can be an obstruction to mechanical brushing – food can often get trapped around the brackets and under the arch wires after eating, and for patients whose treatment is lengthy it can be a challenge to maintain good oral health and avoid enamel demineralisation, periodontal disease, halitosis and teeth staining [3].

In recent years there has been an increase in interest to the subject. In 2017 the number of publications on PubMed (Medline) related to the topic reached 89 compared to 78 in 2014. However, there is still a lack of knowledge on how to ensure personalized oral care for each patient.

**Aim of the study** – to analyse scientific literature and reason the importance of individual oral hygiene in prevention of oral diseases.

**Role of dental plaque biofilm in oral disease development**

Research over the past decade has led to the recognition of dental plaque as a biofilm – a highly organized accumulation of microbial communities attached to an environmental surface. Biofilms are organized to maximize spatial arrangements, communication, and continuity of the community of microorganisms. Biofilm formation enables single-cell organisms to assume a temporary multicellular lifestyle, in which "group behaviour" facilitates survival in adverse environments. What was once defined as the formation of a community of microorganisms attached to a surface has come to be recognized as a complex developmental process that is multifaceted and dynamic in nature. The transition from planktonic growth to

biofilm occurs in response to environmental changes, and involves multiple regulatory networks, which translate signals to concerted gene expression changes thereby mediating the spatial and temporal reorganization of the bacteria [4-7]. This cellular reprogramming alters the expression of surface molecules, nutrient utilization, and virulence factors and equips bacteria with an arsenal of properties that enable their survival in unfavourable conditions [8-15; 6].

Within the biofilm, bacteria are cocooned in a self-produced extracellular matrix, which accounts for ~90% of the biomass [16]. The slimy extracellular matrix encloses the microbial community and protects it from the surrounding environment, including attacks from chemotherapeutic agents. Chemotherapeutic agents have difficulty penetrating the polysaccharide matrix to reach and affect the microorganisms. Thus, the matrix helps protect bacteria deep within the biofilm from antibiotics and antiseptics, increasing the likelihood of the colonies' survival. Furthermore, the extracellular matrix keeps the bacteria banded together, so they are not flushed away by the action of saliva and gingival crevicular fluid. Mechanical methods, including tooth brushing, interdental cleaning, and professional scaling procedures, are required to regularly and effectively disrupt and remove the plaque biofilm. Antiseptics, such as mouthwashes, can help to control the biofilm but must be formulated so as to be able to penetrate the plaque matrix and gain access to the pathogenic bacteria [2].

The discovery that communication between cells in biofilm communities occurs has been a key in understanding how dental plaque acts as a single unit. Communication can occur in a variety of ways, including gene expression, cell-cell signalling (ex. quorum sensing), and antibiotic resistance, among others. Specific bacteria within the biofilm community are able to act with other species to both help and impair the host, in addition to providing a positive cooperation between the different species of the biofilm. Further, the patterns observed of microbial colonization and co-aggregation appear to be primarily unidirectional, thus indicating that many of the bacterial species in dental biofilms require an environment that has been previously habituated by other microbiota in order to properly colonize. These specific cell-cell interactions have proven to be very important topics of current research involving dental plaque biofilms [17].

The growth and development of biofilm are characterized by 4 stages: initial adherence, lag phase, rapid growth, and steady state. Biofilm formation begins with the adherence of bacteria to a tooth surface, followed by a lag phase in which changes in genetic expression (phenotypic shifts) occur. A period of rapid growth then occurs, and an exopolysaccharide matrix is produced. During the steady state, the biofilm reaches growth equilibrium. Surface detachment and sloughing occur, and new bacteria are acquired.

Bacterial communities living in a biofilm possess resourceful survival strategies, including a broader habitat for growth, nutrition, waste elimination, and new colonization; environmental niches for safety; barriers to thwart antimicrobial drug therapy; protection from the host's defence system including phagocytosis; and enhanced pathogenicity. These strategies account for the ongoing challenge of successfully controlling periodontal infection and disease progression [16]. As the biofilm matures and proliferates, soluble compounds produced by pathogenic bacteria penetrate the sulcular epithelium. These compounds stimulate host cells to produce chemical mediators associated with the inflammatory process.

The result of this chronic inflammation is a breakdown of gingival collagen and accumulation of an inflammatory infiltrate, leading to the clinical signs of gingivitis. In some individuals, the inflammatory process will also lead to the breakdown of collagen in the periodontal ligament and resorption of the supporting alveolar bone. It is at this point that the lesion progresses from gingivitis to periodontitis, continuing the same challenge from proinflammatory mediators as with chronic gingivitis [2].

Thus, controlling dental plaque biofilm is essential to preventing and reversing gingivitis as well as preventing and managing periodontitis.

**Scientific evidence-based advantages and disadvantages of manual and electric toothbrushes**

The first true bristled toothbrush was originated in China at around 1600 AD. The first modern toothbrush was reinvented in the late 18$^{th}$ and early 19$^{th}$ centuries. The first patent for a toothbrush was credited to H. N. Wadsworth in 1857, in the United States, but due to the high price of the hog bristle, the mass production of the product in America only started in the end of the 19$^{th}$ century. The first electric toothbrush, an attempt to offer the public a brush that could simulate the action of a manual brush, was developed in 1939 in Scotland, but did not appear on the market until the 1960s. During recent years, synthetic plastic materials have taken the place, almost completely, of all other materials for the stock or body of the toothbrush. They are entirely satisfactory from every standpoint and superior in many particulars [18].

One of the advantages of powered brushes in general is their ability to remove a greater amount of plaque in a given period of time than manual brushes. Robinson et al. [19] conducted a meta-analysis of manual and powered toothbrushes categorized by mode of action, finding that the rotation-oscillation brushes reduced plaque and gingivitis more than the manual brushes, with a 7% reduction in plaque index and a 17% reduction in bleeding-upon-probing index. Sonic toothbrushes work just like ordinary ones: they move back and forth over the surface of the teeth at high speed, scrubbing away the plaque. The most obvious difference is the speed of the movement: sonic brushes typically vibrate at about 260 Hz (260 times per second), which translates into 31,000 brush strokes per minute – about 10 times faster than ordinary electric toothbrushes. In a normal electric toothbrush, the very top part of the brush rotates back and forth thanks to a little cam unit just above the motor. The rest of the brush head is stationary. With sonic toothbrushes, the entire brush head vibrates very quickly – and the manufacturers claim this produces a different type of cleaning action that makes them more effective [20].

The ultrasonic toothbrushes use ultrasonic waves to clean the teeth. In order for a toothbrush to be considered "ultrasonic" it has to emit a wave at a minimum frequency of 20,000 Hz or 2,400,000 movements per minute. Typically, ultrasonic toothbrushes approved by the U.S. Food and Drug Administration (FDA) operate at a frequency of 1.6 MHz, which translates to 192,000,000 movements per minute [1]. Ultrasonic toothbrushes emit vibrations that are very high in frequency but low in amplitude. These vibrations break up bacterial chains that make up dental plaque and remove their methods of attachment to the tooth surface up to 5 mm below the gum line.

Costa et al. [21] studied plaque and gingival indices for reductions with either manual or sonic/ultrasonic brushes. Both types were found to provide reductions; however, for orthodontic and dental implant patients, a greater reduction was found with sonic brushes.

One study compared the volume of dental biofilm and fluoride retention following brushing with a rotation-oscillation, sonic or manual brush or a manual brush plus flossing. Sonic brushing resulted in the least remaining plaque, with a 43% to 65% reduction compared to all other treatments. With respect to fluoride retention, use of a sonic brush resulted in greater fluoride retention from the first day, and after a week resulted in 40% greater fluoride concentration than any other treatment, the least effective being manual brushing and flossing [22].

Research findings suggest the importance of brushing time. The recommended duration often is 2 minutes, and some models of power toothbrushes have 2-minute timers to encourage adherence. The average brushing time is 1 minute or less but evidence indicates that, as brushing times increase, efficacy also increases. There is no standard recommendation for how many times per day persons should brush. From a practical view-point, patients are told to brush their teeth at least twice daily to control plaque biofilm (i.e., in the morning and at night). However, decisions about when and how often to brush must be made through a shared decision-making process based on clinical findings and patient's preferences [20].

Most literature on force applied during tooth brushing has focused on its association with damaging soft and hard tissues. It has been reported that poor oral hygiene and abrasive brushing are cause or risk factors that favour the gingival recession.

The study carried out in the South of Chile revealed that in relation to the method of brushing teeth and toothbrush type, the combined method and the use of manual brush were the variables that showed a higher frequency of gingival recession. The brushing technique less associated with gingival recession was horizontal (1.1%), in contrast to the combined technique (60.6%) which was mostly associated with gingival recession of the total affected teeth. Additionally, it was noted that 64.1% of the affected teeth was related to brushing frequency of 3 or more times a day [23].

It does not really matter whichever technique and brush are used as long as the patient is removing plaque effectively without causing any damage. Good oral hygiene and oral care at home are a key element to prevent any form of dental disease. The efficient tooth brushing is the first step towards dental care and is a conveniently accessible dental device which helps to prevent dental problems.

**Effects of toothpastes in prevention of oral diseases**

Dentifrices come in powders, liquid gels, gels, pastes, foams and gel-paste combinations and are selected to meet particular patient needs. Since the late 1960s, following the introduction of widespread use of fluoridated dentifrices, there has been a substantial decrease in caries within Western populations. Toothpastes have been widely used since ancient times as cleaning agents. But it was only in the last century that effective therapeutics, mainly

fluoride, were incorporated into their formula [24]. Therefore, more than merely cosmetic products, toothpastes have become essential for oral health maintenance.

Among the components of toothpaste formulations, two deserve further discussion given their important role in the mode of action of toothpastes – abrasives and therapeutic agents. Abrasive agents are used to clean and polish teeth to the smooth, lustrous surface and their origins are natural or synthetic.

If abrasive capacity of dentifrice abrasive agent is too low, the abrasive agent is less effective in removing the soft deposits and stains. If it is too high, it may increase abrasion of tooth structure and restored tooth surfaces, especially with excessive tooth brushing force.

Mohs Hardness Scale rates the hardness of materials, with 1 being the softest and 10 being the hardest. The Scale is useful for understanding abrasiveness of cleaning and polishing agents. For example, the threshold of 2 to 4 is equal to the hardness of cementum or dentin, often exposed because of gingival recession. Dentifrices whose level of abrasiveness is 2 or less are recommended to avoid tooth structure loss on exposed roots. Children can use a more abrasive dentifrice when their tooth enamel is mature [25].

Common fluorides found in daily-use dentifrice formulas include $SnF_2$, NaF, MFP, and $SnF_2$-sodium hexametaphosphate. A dentifrice with 0.24% NaF has an efficacy equivalent to a dentifrice containing 0.76% MFP. These two concentrations differ because the agents don't have the same molecular weight. Fluoride levels in dentifrices vary among countries. In Europe dentifrices may contain from 250 ppm to 10 000 ppm of fluoride. In North America, the levels are between 400 ppm (for children) and 5000 ppm of fluoride. Most products contain about 1000 ppm [26].

Where fluoride concentration in toothpastes is concerned, a long debate can be observed in the literature regarding the anticaries effect of low-fluoride toothpastes (e.g. 500 ppm of fluoride). Originally marketed to overcome potential fluorosis risks due to inadvertent ingestion of toothpaste by young children during tooth brushing [27-29], low-fluoride toothpastes are available in many countries and are even endorsed by some governmental oral health agencies. However, their anticaries effect has not been confirmed in systematic reviews [30]. In experiments designed to evaluate the anticaries effect of low-fluoride toothpastes under different cariogenic conditions, it was demonstrated that, for caries-active children or for those subject to a high cariogenic challenge (biofilm accumulation and exposure to sugar 6–8 times/day), low-fluoride toothpaste is significantly less effective than conventional fluoride toothpaste (1100 ppm) in controlling caries progression. Considering the data currently available on the anticaries effect of toothpastes with different fluoride concentrations on children and adolescents or on primary dentition of preschool children, the only scientific-based recommendation is that a small amount of toothpaste with at least 1000 ppm be used, irrespective of child's age [28; 30].

A Cochrane review stated that there was evidence to support that toothpastes with 1000 ppm were associated with a higher risk of fluorosis when used in children aged 5-6 years [3]. They did, however, caveat this statement by indicating that the benefit of caries prevention may well outweigh the risk of aesthetically objectionable fluorosis. It was also noted that fluoride toothpastes above 1450 ppm should be usually restricted to individuals aged over 6 years and, in most jurisdictions, are prescribed by health professionals following an appropriate risk assessment. Young children lack complete mastery of the swallowing reflex and children under the age of 6 years may ingest 25-65% of the dentifrice which is placed on the toothbrush [31].

When root caries is a concern, since dentine is more soluble than enamel, fluoride toothpaste is expected to be less effective in controlling dentin caries than in controlling enamel caries. Therefore, high fluoride toothpastes (e.g. 5000 ppm) marketed to control root caries have been shown by clinical trials to have a higher effectiveness than conventional-concentration toothpastes (1000–1500 ppm) [32].

Leon (2018) et al. [33] also found and demonstrated in a clinical study with 5000 ppm fluoride toothpaste that it is significantly better at remineralizing primary root caries lesions than one containing 1100 ppm of fluoride. Singh and Purohit (2018) [34] compared the efficacy between daily use of two toothpastes, one with 5000 ppm and the other containing 1450 ppm of fluoride on patients older than 75 years for 8 months. The 5000 ppm fluoride toothpaste showed significantly better effect in controlling root caries development supporting the hypothesis that higher fluoride concentrations in toothpaste may be beneficial for the control of root caries.

Although fluoride is the cornerstone of the anticaries agents in toothpastes, there is more than just fluoride. A number of co-adjuvant anticaries agents have been tested and made available in toothpaste formulations, with evidence of effectiveness. One of the most tested is triclosan. Formulations containing triclosan/copolymer have been shown to significantly reduce gingival inflammation and the progression of gingivitis to periodontitis, calculus and halitosis [35]. Stannous fluoride toothpastes were also shown to have a significant effect on biofilm

reduction and gingivitis [36]. Regarding dentin hypersensitivity, the evidence to support potassium-containing toothpastes is not sound enough. More recent formulations, such as arginine-based toothpastes, have shown promising results in clinical trials to be confirmed by systematic reviews of the literature [37]. The control of calculus formation by toothpastes is based on evidence, especially for formulations containing pyrophosphates, zinc compounds and co-polymers [32].

Some ingredients in toothpaste can affect the overall health of people who suffer from allergies or intolerance: for example, dyes, natural flavours (e.g. strawberries or cinnamon), milk derivatives, eggs, and even derivatives of aspirin (acetylsalicylic acid as methyl hydroxybenzoate). In addition, there may be negative effects of certain ingredients. Toothpaste ingredients that are not safe for ingestion may be ingested, especially by children or people with learning disabilities. Some ingredients may contribute to damage to hard tissues (abrasion, staining) and occasionally soft tissues.

Consequently, the choice of toothpaste is an important element to be considered by the healthcare professional because this product has a direct impact on dental health, overall health, and quality of life of the patient.

**Importance of interdental cleaning in prevention of oral diseases**

It has been shown that a manual toothbrush used alone on average reduces plaque scores by 42% and will not reach the interdental surfaces [22]. Consequently, an additional interdental cleaning device is always needed. Several such tools are available on the market; i.e., floss, toothpicks, interdental brushes, oral irrigator etc. There is not one single interdental cleaning device which suits all patients and interdental spaces; therefore, the choice recommended for a specific patient needs to be based on clinical experience and scientific knowledge.

Not all interproximal contact areas, whether natural or restored, have the same configuration. In order to accomodate these differences, several types of floss are available. These vary from thin unwaxed varieties to thicker waxed types and include variable thickness floss. Clinical trials have shown no significant differences in the cleaning ability between waxed and unwaxed floss [38]. Wax residue has not been found on tooth surfaces cleaned with waxed floss. Unwaxed silk floss was first produced in 1882, by Codman & Shurtleff, but it was Johnson & Johnson who made silk floss widely available from 1887, as a by-product of sterile silk leftover from the manufacture of sterile sutures. Unwaxed floss is frequently recommemned because it is thin and slips easily through tight contact areas. However, it can fray and tear when contacting rotated teeth, heavy calculus deposits, or defective and overhanging restorations. For such conditions, waxed, lightly waxed resistant floss are recommended. Waxed dental tape, unlike round dental floss, is broad and flat, and may be effective in an interproximal space without tight contact points [39].

Flosses impregnated with a variety of agents have been introduced; examples of these include floss treated with baking soda, fluoride, herbal extracts, antimicrobial agents, or abrasives for whitening. Fluoride impregnated floss has been marketed but lacks efficacy data for affecting the caries rate [38]. A limitation of flossing is the inability to conform to a concave interproximal surface such as the mesial of maxillary premolars. Other interproximal devices clean those surfaces more effectively.

Certain organisations, for example the American Dental Association, recommend that children's teeth are flossed as soon as they have two teeth that touch. However, studies that measure compliance show that few children have their teeth flossed or use floss: a study in West Virginia found that only 21% of children had their teeth flossed [40]. When measures are taken to increase compliance, for example using behavioural change techniques, then the proportion of adolescent flossing increase. Since dental floss is able to remove some interproximal plaque, it is thought that frequent regular dental flossing will reduce the risk of periodontal disease and interproximal caries [41].

Daily dental flossing in combination with tooth brushing for the prevention of periodontal disease and caries is frequently recommended. The results of the study conducted by Grellmann et al. [42] revealed that flossing detects more bleeding at proximal sites than did gingival bleeding index in subjects without periodontal attachment loss and periodontal pockets. Flossing rubbed against the gingival tissue appears to be a more appropriate method for the diagnosis of gingivitis. The differences in the evaluation methods were largest at posterior sites.

Originally, interdental brushes were recommended by dental professionals to patients with large embrasure spaces between the teeth [22], caused by the loss of interdental papillae mainly due to periodontal destruction. Patients who had interdental papillae that filled the embrasure space were usually recommended to use dental floss as an interdental cleansing tool. However, with the greater range of interdental brush sizes and cross-sectional diameters

now available, they are considered a potentially suitable alternative to dental floss for patients who have interdental papillae that fill the interdental space [39]. Slot et al. (2008) [22] showed that interdental brushes as an adjunct to brushing remove more dental plaque than tooth brushing alone. The evidence suggests that interdental brushing is the most effective method to interdentally remove plaque. When the papilla fills the interdental space, floss has the potential to reach the involved tooth surfaces. However, when any papillary recession has occurred an interdental brush size should be selected which fits snugly into the entire space to encourage maximum contact between the brush bristles and the tooth surface. Because only scant evidence exists, no systematic reviews are available concerning differences in brush handles (straight or angled), brush shape, filament type, and durability or method of brush insertion into the interproximal site.

Thus, according to numerous clinical experiments brushes efficiently remove plaque from sites where a direct contact between filaments and tooth surfaces takes place. Therefore, the size of the contact area between the filaments of an interdental brush and the approximal surfaces is crucial. Hence, it can be assumed that the cleaning performance is the better the more contacts with a tooth surface are established by the filaments. Guiding the patient in regard to choosing the correct interdental brush size/sizes is of utmost importance; all interdental space varieties in the individual need to be considered.

**Comparative efficacy of different individual dental hygiene aids in controlling interproximal biofilm**

In adults, most studies have demonstrated that conventional toothbrushes are not as effective in plaque removal as would be expected. The results of clinical study [43] showed that most individuals remove only 50% of plaque with conventional brushing, whereas Lang (1973 and 2014) [44; 45] asserted that most people do not properly perform oral hygiene and most likely carry much plaque on their teeth, although they brush their teeth at least once a day.

Dental floss and interdental brushes are the most commonly recommended, advertised and available aids for cleaning between the teeth. In early August 2016 dental flossing hit the mainstream news headlines following news that the United States Department of Health has removed daily flossing from its list of dental recommendations. Despite American dentists having recommended the use of floss to patients since the 1800s, a report by the Associated Press (AP) has found that ‘‘there's little proof that flossing works”. This report sent a shock wave through the dental community. It brought back to the surface the debate between flossing and its alternatives.

Several studies have compared dental floss and interdental brushes in respect to their influence on plaque and gingivitis. Patient preference is also a factor that has been evaluated.

In an examiner-blinded, randomized split-mouth clinical trial, interdental brushes were shown to significantly reduce bleeding sites in subjects with Type I embrasures [39]. In addition, a systematic review concluded that interdental brushes are an effective alternative to dental floss for reducing interproximal bleeding and plaque, also in subjects with Type I embrasures [46].

A significant proportion of the research conducted to evaluate and to compare interdental cleaning devices is performed on subjects with embrasure Type II or III [47].

Interdental brushes are shown to have a positive effect on parameters such as bleeding, plaque and pocket reduction. They are also superior to other manual interdental cleaning devices in subjects, who either suffered from periodontitis or were included in a maintenance program after periodontal treatment [48-52].

A systematic review based on nine randomised controlled trials (RCTs), showed a positively significant difference in using interdental brushes with respect to plaque scores, bleeding scores, and probing pocket depth, compared to other interdental cleaning devices. An essential difference favouring interdental brush use on plaque was observed for all three RCTs comparing interdental brushing to brushing alone, for five of the eight RCTs comparing interdental brushes to floss, and for one of the two RCTs comparing interdental brushes to woodsticks. Two out of three RCTs found a favourable effect for interdental brushes on pocket depth compared to floss. Thus, the majority of trials showed a positive significant difference in plaque index for interdental brushes compared to floss [22]. The findings of Christou et al. (1998) [49] and Jackson et al. (2006) [51] also statistically demonstrated a significantly lower rate of plaque with the use of interdental brushes compared with dental floss.

Christou [49] demonstrated that patients with moderate to severe periodontitis who used an interdental brush (to remove plaque and reduce periodontal pockets) obtained a higher efficacy than those individuals who used dental floss. Jackson [51], in his most recent work, observed a significant greater reduction in all parameters (plaque index, level of papillae and

probing depth) in the group using interdental brushes compared with the group that used dental floss, after 12 weeks of observation.

A meta-review done by Sälzer et al. (2015) [53] concluded that there is consistent evidence for interdental brushes being the most effective devices for interdental plaque removal. This is also stated in the report of the 11th European Workshop in Periodontology on primary prevention of periodontitis [54]. According to the working group, interdental brushes are the preferred choice for interdental cleaning. Floss can be an alternative only when sites are too narrow for the interdental brush and show gingival and periodontal health.

The February 2012 issue of the Canadian Journal of Dental Hygiene presented a systematic review in which they narrowed 62 publications to seven studies that met their criteria for evaluating interdental brushes and floss effectiveness. From this systematic review, a flow chart of guidelines for patients with inflamed gingiva was created in which it was recommended that as well as for patients with good dexterity and Type 1 embrasures, interdental brushes should be the product of choice for interproximal cleaning. The systematic review also concluded that interdental brushes were superior to floss in the reduction of bleeding and plaque within a 4- to 12-week time period.

Interdental brushes and dental floss have been also compared from a patient preference perspective, in favour of the interdental brush [49; 54; 55]. Studies have shown that most patients preferred the interdental brush over floss, that they felt the interdental brush to be both more efficient and easier to use, and that they were more willing to use the interdental brush. These factors may all contribute to enhancing the individual's oral self-care compliance.

Another study conducted by Särner et al. [56] questioned the differences in effectiveness not only between floss and interdental brushes but also between toothpicks. The investigators acknowledged the idea that proximal sides of teeth usually have some curvature or concavity present. Therefore, when using the different methods, the effectiveness would vary, although at the very least, some proximal plaque would be removed with each approach. In order to complete the comparisons, investigators simulated the presence of bacterial plaque on the surfaces of extracted teeth and observed the differences in effectiveness of each device. Their findings showed that floss and toothpicks encountered more significant limitations on removing plaque, especially on the surfaces of the teeth that had concavities. Floss could be effective on flatter areas. Toothpicks, while potentially able to reach within the concavities, were limited by patients' ability to maneuver them between adjacent teeth and by challenges of individuals with manual dexterity. Interdental brushes were most effective as some of the bristles could press against the outer areas while other bristles could extend into the concavities as they are manipulated back and forth against the surfaces of neighbouring teeth. The largest plaque reduction was produced by the interdental brush (83%), followed by toothpicks (74%) and dental floss (73%).

When talking about oral irrigator, the Waterpik® Water Flosser has been compared to dental floss in three different studies. The first study by Lyle et al. [57], published in 2016, compared a water flosser plus either a powered toothbrush or a manual toothbrush to a manual toothbrush and string floss. The 4-week study showed that regardless of the toothbrush used, the water flosser was significantly better at reducing bleeding and gingivitis than a manual toothbrush and string floss.

The most recent study was published in 2011. Over a 4-week period, subjects used either a water flosser with a traditional jet tip, a water flosser plus a jet tip with three tufts of bristles, or string floss. All subjects brushed using a manual toothbrush twice a day. In both water flosser groups, bleeding was significantly reduced compared with the string floss group. At 2 weeks, the traditional tip was shown to be twice as effective as string floss. At the end of the study, the differences were even greater [58].

Thus, considering all the subsequent reviews of the available literature, the evidence does not demonstrate an advantage of flossing over other interproximal oral hygiene methods in terms of periodontal or tooth surface (anti-caries) health [41; 53; 59]. It was concluded that "a routine instruction to use floss is not supported by scientific evidence" [60]. In fact, other methods of patient driven debridement may be more effective than flossing. Effective interproximal hygiene requires a device that affects as much of the exposed tooth surface as possible [53].

It was concluded that motivation was a key element and that the ease of use of a product would affect one's motivation. Although the interdental brush was noted to bend and buckle, study participants preferred the one handed method and time efficiency compared to the efforts required for dental flossing [39]. In other words, interdental plaque removal requires individualised planning, instruction and support to be effective. The focus should be on the desired outcome, rather than the process, kit/technique.

A toothpaste can prevent or control an oral disease or condition when it provides a therapeutic function. It also can be a risk factor if it causes dentine hypersensitivity, erosion, or abrasion. Therefore, dentifrices must be selected to meet the needs of each patient.

Cleaning in between the teeth is particularly important for vulnerable patients, such as the elderly, the very young and those with auto-immune disease who are all more susceptible to infections from the bacteria in their mouth. When recommending an interdental cleaning method many factors such as the contour and consistency of gingival tissues, the size and form of the interproximal embrasure, tooth position, and alignment and patient ability should be taken into consideration.

**Conclusions**

1. Dental biofilm is a complex, organized microbial community that is the primary etiologic factor for the most frequently occurring oral diseases, dental caries and periodontal diseases. It's formation enables bacterial pathogens to colonize a wide variety of host niches and persist in harsh environments. Although the dental biofilm can't be eliminated, it can be controlled with comprehensive mechanical and chemotherapeutic oral hygiene practices. In the healthy state, both plaque biofilm and adjacent tissues maintain a delicate balance and a harmonious crosstalk between the two counterparts.

2. Effective plaque control by tooth brushing is a key self care strategy for maintaining oral health. Patients routinely use toothbrushes to remove supragingival dental plaque, but toothbrushes are unable to penetrate the interdental area where periodontal disease first develops and is prevalent. It necessitates the application of interdental plaque control measures to supplement the toothbrush such as floss, toothpicks, interdental brushes and oral irrigator. There is not one single interdental cleaning device which suits all patients and interdental spaces; therefore, all recommendations need to be tailored and need to be based on clinical experience and scientific knowledge. The choice of interdental cleaning aid will depend on the size of the space and the ability of the patient to use it.

3. Dental floss and interdental brushes are the most commonly recommended, advertised and available aids for cleaning between the teeth. Several studies have compared dental floss and interdental brushes in respect to their effectiveness on the clinical parameters of periodontal inflammation. The analysis of the results of those studies demonstrated that interdental brushes have more positive effect on parameters such as bleeding, plaque and pocket reduction compared to dental floss. Interdental brushes and dental floss have been also compared from a patient preference perspective, in favour of the interdental brush which is considered to be both more efficient and easier to use.

4. Dental disease being a major preventable public health challenge, is both universally prevalent and a significant burden for children and adults. Predictors of oral disease prevalence include public awareness of oral health and dental disease, use of dental services, and self-care which includes daily interdental cleaning and brushing with a fluoride-containing dentifrice. Nowadays there is increasing public awareness of the value of personal oral hygiene but dental compliance is still very often much affected by patients' unwillingness to perform oral self-care, stressful life events, a lack of understanding of the advice and poor perception of oral health problems, a lack of motivation, low socio-economic status and poor dental health beliefs.

**References**

1. Collins F. Toothbrush technology, dentifrices and dental biofilm removal. 2009. Available from:
https://www.dentalacademyofce.com/courses/2076/pdf/1103cei_toothbrush_rev1.pdf

2. Gurenlian JA. The role of dental plaque biofilm in oral health. J Dent Hyg. 2007; 81(5).

3. Mei L, Chieng J, Wong C, Benic G, Farella M. Factors affecting dental biofilm in patients wearing fixed orthodontic appliances. Progress in Orthodontics. 2017; 18:4.

4. Prigent-Combaret C, Brombacher E, Vidal O, Ambert A, Lejeune P, Landini P, Dorel C. Complex regulatory network controls initial adhesion and biofilm formation in Escherichia coli via regulation of the csgD gene. J Bacteriol. 2001; 183: 7213–7223.

5. Parsek MR, Singh PK. Bacterial biofilms: An emerging link to disease pathogenesis. Annu Rev Microbiol. 2003; 57: 677–701.

6. Lenz AP, Williamson KS, Pitts B, Stewart PS, Franklin MJ. Localized gene expression in Pseudomonas aeruginosa biofilms. Appl Environ Microbiol. 2008;74:4463–4471.

7. Monds RD, O'Toole GA. The developmental model of microbial biofilms: Ten years of a paradigm up for review. Trends Microbiol. 2009;17:73–87.

8. Whiteley M., Bangera MG, Bumgarner RE, Parsek MR, Teitzel GM, Lory S, Greenberg EP. Gene expression in Pseudomonas aeruginosa biofilms. Nature. 2001; 413:860–864.

9. Schembri MA, Kjaergaard K, Klemm P. Global gene expression in Escherichia coli biofilms. Mol Microbiol. 2003;48:253–267.

10. Stanley NR, Britton RA, Grossman AD, Lazazzera BA. Identification of catabolite repression as a physiological regulator of biofilm formation by Bacillus subtilis by use of DNA microarrays. J Bacteriol. 2003;185:1951–1957.

11. Bagge N, Hentzer M, Andersen JB, Ciofu O, Givskov M, Hoiby N. Dynamics and spatial distribution of β-lactamase expression in Pseudomonas aeruginosa biofilms. Antimicrob Agents Chemother. 2004;48:1168–1174.

12. Beloin C, Valle J, Latour-Lambert P, Faure P, Kzreminski M, Balestrino D, Haagensen JA, Molin S, Prensier G, Arbeille B. Global impact of mature biofilm lifestyle on Escherichia coli K-12 gene expression. Mol Microbiol 2004;51:659–674.

13. Vuong C, Voyich JM, Fischer ER, Braughton KR, Whitney AR, DeLeo FR, Otto M. Polysaccharide intercellular adhesin (PIA) protects Staphylococcus epidermidis against major components of the human innate immune system. Cell Microbiol. 2004;6:269–275.

14. Zhang L, Mah TF. Involvement of a novel efflux system in biofilm-specific resistance to antibiotics. J Bacteriol. 2008;190:4447–4452.

15. Klebensberger J, Birkenmaier A, Geffers R, Kjelleberg S, Philipp B. SiaA and SiaD are essential for inducing autoaggregation as a specific response to detergent stress in Pseudomonas aeruginosa. Environ Microbiol. 2009;11:3073–3086.

16. Flemming HC, Wingender J. The biofilm matrix. Nat Rev Microbiol. 2010; 8: 623–633.

17. Seneviratne C, Zhang C, Samaranayake L. Dental plaque biofilm in oral health and disease. The Chinese Journal of Dental Research. 2011;14(2):87–94.

18. Kumar G, Jalaluddin M, Singh D. Tooth brush and brushing technique. Journal of Advances in Medicine. 2013;2(1):65–76.

19. Robinson E. A comparative evaluation of the scrub and bass methods of toothbrushing with flossing as an adjunct (in fifth and sixth graders). AJPH. 1976;66(11):1078–1081.

20. Walsh M, Darby L. (2014). Dental hygiene: theory and practice. Available from: https://books.google.co.uk/books?id=K_ULBAAAQBAJ&dq=manual+toothbrush+characteristics&source=gbs_navlinks_s

21. Costa MR., da Silva VC, Miqui MN, Colombo AP, Cirelli JA. Effects of ultrasonic, electric, and manual toothbrushes on subgingival plaque composition in orthodontically banded molars. Am J Orthod Dentofacial Orthop. 2010;137(2):229–235.

22. Slot D, Dörfer C, Van der Weijden G. The efficacy of interdental brushes on plaque and parameters of periodontal inflammation: A systematic review. Int J Dent Hygiene. 2008;6(4):253–264.

23. Beltran V, De La Roza G, Wilckens M, Fuentes R, Padilla M, Aillapan E, Navarro P, Cantin M. Effects of manual toothbrushing on gingival recession in an adult population sample in south of Chile. Int. J. Odontostomat. 2014;8(3):461–467.

24. Addy M, Hunter ML. Can tooth brushing damage your health? Effects on oral and dental tissues. Int Dent J. 2003;53 Suppl 3:177–86.

25. Wiegand A, Schlueter N. The role of oral hygiene: does toothbrushing harm? Monogr Oral Sci. 2014;25:215–219.

26. Bellamy PG, Harris R, Date RF, Mussett AJ, Manley A, Barker ML, Hellin N, West NX. In situ clinical evaluation of a stabilised, stannous fluoride dentifrice. Int Dent J. 2014 Mar;64 Suppl 1:43–50. doi: 10.1111/idj.12102.

27. Carey C. Focus on fluorides: update on the use of fluoride for the prevention of dental caries. J Evid Based Dent Pract. 2014;14:95–102.

28. Cury J, Tenuta L. Evidence-based recommendation on toothpaste use. Braz Oral Res. 2014;28(1):1-7.

29. Azevedo M, Goettems M, Torriani D, Demarco F. Factors associated with dental fluorosis in school children in southern Brazil: Across-sectional study. Braz. Oral Res.2014;28(1):1–7.

30. Walsh T, Worthington HV, Glenny AM, Appelbe P, Marinho VC, Shi X. Fluoride toothpastes in different concentrations for preventing dental caries in children and adolescents. Cochrane Database Syst Rev. 2010;20(1): CD007868. doi: 10.1002/14651858.CD007868.pub2.

31. Tay HL, Zainudin IS, Jaafar N. Fluoride toothpaste utilization behaviour among preschool children in Perlis, Malaysia. Community Dent Health. 2009;26(4):211-5.

32. Davies R, Scully C, Preston AJ. Dentifrices - an update. Med Oral Patol Oral Cir Bucal. 2010;15(6): e976–82.

33. León S, Rivera M, Payero S, Correa-Beltrán G, Hugo FN, Giacaman RA. Assessment of oral health-related quality of life as a function of non-invasive treatment with high-fluoride toothpastes for root caries lesions in community-dwelling elderly. Int Dent J. 2018 Jul 20. doi: 10.1111/idj.12415.

34. Singh A, Purohit BM. Caries Preventive Effects of High-fluoride vs Standard-fluoride Toothpastes - A Systematic Review and Meta-analysis. Oral Health Prev Dent. 2018;16(4):307–314.

35. Cagetti MG, Strohmenger L, Basile V, Abati S, Mastroberardino S, Campus G. Effect of a toothpaste containing triclosan, cetylpyridinium chloride, and essential oils on gingival status in schoolchildren: a randomized clinical pilot study. Quintessence Int. 2015;46(5):437-45.

36. Cheng X, Liu J, Li J, Zhou X, Wang L, Liu J, Xu X. Comparative effect of a stannous fluoride toothpaste and a sodium fluoride toothpaste on a multispecies biofilm. Arch Oral Biol. 2017;74:5–11.

37. Magno MB, Nascimento GC, Da Penha NK, Pessoa OF, Loretto SC, Maia LC. Difference in effectiveness between strontium acetate and arginine-based toothpastes to relieve dentin hypersensitivity. A systematic review. Am J Dent. 2015;28(1):40–44.

38. Hiremath S. Textbook on preventive and community dentistry. 2011. Available from: https://books.google.co.uk/books?id=Tz9cWJ3yUycC&pg=PA421&lpg=PA421&dq=toothpick+in+dentistry&source=bl&ots=PzaOQreBRX&sig=UmMzvr-JDvuCq7JyCSDgJO0UjO4&hl=en&sa=X&ved=0ahUKEwj84bLyvP_WAhWrAJoKHYGGBog4FBDoAQhEMAA#v=onepage&q=toothpick%20in%20dentistry&f=false

39. Johnson T, Worthington H, Clarkson J, Poklepovic P, Sambunjak D, Imai P. Mechanical interdental cleaning for preventing and controlling periodontal diseases and dental caries. Cochrane Database of Systematic Reviews. 2015, Issue 12. doi: 10.1002/14651858.CD012018.

40. Wiener RC, Crout RJ, Wiener MA. Toothpaste use by children, oral hygiene, and nutritional education: an assessment of parental performance. J Dent Hyg. 2009;83(3):141–145.

41. Hujoel PP, Cunha-Cruz J, Banting DW, Loesche WJ. Dental flossing and interproximal caries: a systematic review. J Dent Res. 2006;85(4):298–305.

42. Grellmann A, Kantorski K, Ardenghi T, Moreira C, Danesi C, Zanatta F. Dental flossing as a diagnostic method for proximal gingivitis: A validation study. Braz. Oral Res. 2016;30(1):e68.

43. Braun A, Krause F, Frentzen M, Jepsen S. Efficiency of subgingival calculus removal with the Vector-system compared to ultrasonic scaling and hand instrumentation in vitro. J Periodontal Res. 2005;40(1):48–52.

44. Lang NP, Cumming BR, Löe H. Toothbrushing frequency as it relates to plaque development and gingival health. J Periodontol. 1973 Jul;44(7):396–405.

45. Lang T, Staufer S, Jennes B, Gaengler P. Clinical validation of robot simulation of toothbrushing-comparative plaque removal efficacy. BMC Oral Health. 2014;4;14–82.

46. Bourgeois D, Carrouel F, Llodra J, Bravo M, Viennot S. A colorimetric interdental probe as a standard method to evaluate interdental efficacy of interdental brush. Open Dent J. 2015; 9:431–437.

47. Nordland WP, Tarnow DP. A classification system for loss of papillary height. J Periodontol 1998; 69(10):1124-1126.

48. Kiger RD, Nylund K, Feller RP. A comparison of proximal plaque removal using floss and interdental brushes. J Clin Periodontol. 1991;18(9):681–684.

49. Christou V, Timmerman MF, Van der Velden U, Van der Weijden FA. Comparison of different approaches of interdental oral hygiene: interdental brushes versus dental floss. J Periodontol. 1998; 69(7):759–764.

50. Jared H, Zhong Y, Rowe M, Ebisutani K, Tanaka T, Takase N. Clinical trial of a novel interdental brush cleaning system. J Clin Dent. 2005;16(2):47–52.

51. Jackson MA, Kellett M, Worthington HV, Clerehugh V. Comparison of interdental cleaning methods: a randomized controlled trial. J Periodontol. 2006;77(8):1421–1429.

52. Rösing CK, Aass AM, Mavropoulos A, Gjermo P. Clinical and radiographic effects of enamel matrix derivative in the treatment of intrabony periodontal defects: a 12-month longitudinal placebo-controlled clinical trial in adult periodontitis patients. J Periodontol. 2005;76(1):129–133.

53. Sälzer S, Slot DE, Van der Weijden FA, Dörfer CE. Efficacy of inter-dental mechanical plaque control in managing gingivitis-a meta-review. J Clin Periodontol. 2015;42 Suppl 16: 92–105.

54. Chapple IL, Van der Weijden F, Doerfer C, Herrera D, Shapira L, Polak D, Madianos P, Louropoulou A, Machtei E, Donos N, Greenwell H, Van Winkelhoff AJ, Eren Kuru B, Arweiler N, Teughels W, Aimetti M, Molina A, Montero E, Graziani F. Primary prevention of periodontitis: managing gingivitis. J Clin Periodontol. 2015 Apr;42 Suppl 16: 71–6.

55. Noorlin I, Watts TL. A comparison of the efficacy and ease of use of dental floss and interproximal brushes in a randomised split mouth trial incorporating an assessment of subgingival plaque. Oral Health Prev Dent. 2007;5(1):13–18.

56. Särner B, Birkhed D, Andersson P, Lingström P. Recommendations by dental staff and use of toothpicks, dental floss and interdental brushes for approximal cleaning in an adult Swedish population. Oral Health Prev Dent. 2010;8(2):185–194.

57. Lyle DM, Goyal CR, Qaqish JG, Schuller R. Comparison of Water Flosser and Interdental Brush on Plaque Removal: A Single-Use Pilot Study. J Clin Dent. 2016;27(1):23–26.

58. Rosema NA, Hennequin-Hoenderdos NL, Berchier CE, Slot DE, Lyle DM, van der Weijden GA. The effect of different interdental cleaning devices on gingival bleeding. J Int Acad Periodontol. 2011;13(1):2–10.

59. Sambunjak D, Nickerson JW, Poklepovic T, Johnson TM, Imai P, Tugwell P, Worthington HV. Flossing for the management of periodontal diseases and dental caries in adults. Cochrane Database Syst Rev. 2011 Dec 7;(12):CD008829. doi: 10.1002/14651858.CD008829.pub2.

60. Berchier CE, Slot DE, Haps S, Van der Weijden GA. The efficacy of dental floss in addition to a toothbrush on plaque and parameters of gingival inflammation: a systematic review. Int J Dent Hyg. 2008;6(4):265–79.

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