

FLOSSING

Canadian Dental Hygienists Association Position Statement

Based on current research, dental hygienists are strongly encouraged to make recommendations to clients supporting mechanical interdental cleansing as an adjunct to toothbrushing in order to control plaque accumulation and to prevent and/or control periodontal diseases. While studies have shown it is difficult to stimulate change in patients' oral health care behaviours, others have shown that it can be influenced and provoked. Dental hygienists should be aware of possible personal biases toward flossing, particularly manual finger flossing and specific floss types, and preferably make interproximal cleansing recommendations based on clients' oral conditions, preferences, and abilities.

CDHA Position Paper

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INTRODUCTION

DENTAL HYGIENISTS ARE OFTEN THE PRIMARY SOURCE for professional information on oral disease prevention for those members of the public who are able to access oral care.^{1,2} Dental hygienists are viewed as having both the appropriate knowledge base and an acute understanding of the individual needs of their clients. Chairside oral health education is considered a traditional dental hygiene service and is believed to improve oral health.^{2,3} With studies continuously being conducted on preventive oral hygiene strategies and technological advances that occur steadily, dental hygienists are required to monitor and update their knowledge to ensure it is current.

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In contemporary understanding, the origin and progression of periodontal diseases and dental caries is believed to occur through the colonization and subsequent accumulation of bacterial plaque,^{4,9} mediated by the host inflammatory response.^{6,8} This places oral bacteria, in the form of plaque biofilms, as an essential component in the disease process. While mechanical plaque removal, either by toothbrushing and/or flossing, has a lesser effect on caries prevention compared with fluoride,¹⁰ this has not been considered true for gingivitis. Therefore, much of preventive oral health care—particularly educating clients about home care—has focused on thorough plaque removal to prevent, reduce the severity of, or reverse these disease processes.^{4,8}

The American Academy of Periodontology has attributed the decline in the prevalence of gingivitis in the

United States to improved oral hygiene practices.¹¹ Despite this, clients appear to be less than ideally effective in maintaining their oral health.⁷ While U.S. data have reported that almost two-thirds of the population has gingivitis,¹² measuring the prevalence of periodontitis is less straightforward.¹³ The American Academy of Periodontology position paper on the epidemiology of periodontal diseases states that the milder forms of periodontitis are nearly universal, while those forms leading to a risk of tooth loss are less prevalent.¹³ Although few oral sites with gingivitis progress to periodontitis, the paper states that preventing gingivitis is the first step in preventing periodontitis.¹³

In addressing plaque-mediated oral disease, dental professionals, including dental hygienists, have traditionally recommended daily mechanical plaque removal and more specifically, toothbrushing in conjunction with flossing.^{7,8} Both the Canadian Dental Hygienists Association (CDHA) and the American Dental Hygienists' Association (ADHA), along with the Canadian Dental Association (CDA), support this practice on publicly accessible websites.¹⁴⁻¹⁶ The American Dental Association (ADA) has recommended for nearly a century that individuals follow this routine at least once every 48 hours in order to maintain gingival health.^{12,17,18}

The purpose of this paper is to investigate the current state of the evidence of flossing as a home care procedure to control periodontal diseases, and more specifically gingivitis, in order to provide dental hygienists with up-to-date evidence on which to base recommendations for their clients.

LITERATURE REVIEW

Theoretical basis for flossing

Despite recent advances in oral chemotherapeutics, mechanical removal of plaque remains the primary method for controlling supra-gingival accumulations.¹⁹

Flossing has been shown to be effective in cleaning interproximal surfaces of teeth from the contact point to the sulcus.

Toothbrushing with dentifrice takes place nearly everywhere and has been documented as the most widely used oral hygiene habit in the industrialized world.^{17,20} While toothbrushing is an effective means for removing plaque on many tooth surfaces, it is incapable of removing plaque completely on its own.⁴ Research has shown that toothbrushing is less effective than other means of interproximal plaque removal^{9,21,22} and that proximal surfaces of posterior teeth are the least accessible smooth surfaces.²⁰ This limitation has contributed to the inefficiency of toothbrushing in controlling interproximal gingival bleeding.⁸

Research has shown powered toothbrushing to have improved efficacy in interproximal plaque removal compared with manual toothbrushing even when combined with flossing.²⁰ Caution should be exercised when assessing these particular findings, however. The findings are based on a short-term study with relatively young (mean age 25) study subjects, the outcome measure was limited to the wet weight of interproximal plaque, and no gingival assessment was made.²⁰ Systematic reviews of powered

toothbrushing have been conducted and should be accessed when making oral hygiene recommendations.²³

Conversely, flossing has been shown to be effective in cleaning interproximal surfaces of teeth from the contact point to the sulcus^{7,10,24} and has not been shown to produce unfavourable consequences.²⁵ The ADA has reported that flossing is capable of removing up to 80% of plaque interdentally in a “normal” dentition, meaning that “the interdental space is filled with gingival papilla.”⁵ The improved access of floss into the interdental sulcular area has translated into improved interproximal gingival health beyond that which can be achieved with conventional toothbrushing alone.^{8,17} Studies have shown that both plaque and gingivitis scores are reduced when clients incorporate flossing into their toothbrushing home care regimen.^{8,18} As periodontal disease most commonly affects the interproximal sites,^{5,9,18,21,26,27} it is important that these areas benefit from a concentrated effort in home care regimens.

It is important to recognize that when one is assessing the effectiveness of interdental cleansing methods, two points of reference should be considered. The first and most obvious is the theoretical efficacy of the method, based on the clinical evidence. A second point of reference is the practical efficacy influenced by the acceptability of the method to clients and therefore their compliance.^{9,27} Historically, client compliance with regular flossing has been far less than ideal. The routine use of dental floss has

Déclaration de l’ACHD sur l’utilisation de la soie dentaire

En se fondant sur la recherche actuelle, les hygiénistes dentaires sont fortement encouragées à recommander aux clients des méthodes nettoyage interdentaire mécaniques, en plus du brossage de dents, afin de contrôler l’accumulation de plaque et prévenir ou contrôler les maladies parodontales. Bien que certaines études ont démontré qu’il est difficile d’inciter des clients à modifier leur comportement en matière de soins de santé buccodentaire, d’autres ont démontré qu’il est possible d’influencer des clients et de provoquer des changements de comportement. Les hygiénistes dentaires doivent être conscientes des préjugés personnels possibles sur l’utilisation de la soie dentaire, particulièrement concernant la technique manuelle pour le passage de la soie dentaire à l’aide des doigts, ainsi que sur les différents types de soie dentaire, et, préférablement, devraient recommander un nettoyage interdentaire en tenant compte des affections buccales, des préférences et des habiletés des clients.

RECOMMANDATIONS

1. Le brossage quotidien des dents devrait toujours être complété par quelques-unes des méthodes de nettoyage interdentaire afin de prévenir, réduire et traiter la gingivite chez les adultes.
2. L’utilisation quotidienne de la soie dentaire avec n’importe lequel des types de soie dentaire peut être incluse comme une aide possible de nettoyage interdentaire, en plus du brossage de dents.
3. L’utilisation de la soie dentaire devrait être reconnue comme présentant des limites d’efficacité dans les cas où il y a présence de récession/perte de l’attachement et /ou embrasures.
4. Plusieurs aides à l’utilisation de la soie dentaire et plusieurs nettoyeurs interdentaires, incluant les porte-soie, les porte-soie électriques, les brosses interdentaires, les cure-dents en plastique ou en bois, et certains irrigateurs buccaux à utiliser à la maison sont des alternatives viables au passage de la soie dentaire à l’aide des doigts.
5. Les hygiénistes dentaires devraient être conscientes qu’il peut y avoir des préjugés personnels contre les aides « traditionnelles » d’hygiène buccale, comme l’utilisation de la soie dentaire, et essayer d’être plus réceptives concernant les autres types d’aides et les alternatives mécaniques.
6. Les hygiénistes dentaires devraient adapter leur éducation et leurs directives en hygiène buccale selon les besoins et les préférences spécifiques de leurs clients.

consistently been shown to be dramatically low. Research has shown a range of daily use among adults ranging from 10% to as high as 30%.^{4,17,18,22,28-30} The reasons for this lack of compliance apparently encompass two issues: first, a lack of patient ability;^{18,20,21,24,31,32} second, a lack of motivation.^{18,20,21,24,32} Of course, the second factor may be highly related to the first.

Studies are inconsistent in their ability to demonstrate that educational attempts to influence floss frequency can be successful. While it has been shown that flossing is like other skills in that it can be taught and clients who are given appropriate instruction will increase their flossing frequency,^{18,33} other studies have shown that educational attempts to modify client behaviour have not been successful in improving floss frequency.⁸ While ethnicity, socio-economic status, age, and gender have all been shown to affect the frequency of flossing,^{18,22} the literature has repeatedly suggested that less-demanding means of cleansing interproximal tooth surfaces are required for a real impact on behaviours to be realized.^{20,32}

Dental hygienists and their clients are faced with a myriad of new products designed for interproximal tooth

cleansing and this influx will continue, if not increase. It is therefore important that the effectiveness of these products be assessed and understood.

Floss holders, interproximal brushes, and power flossers had all demonstrated plaque-removal ability and reduction of gingival inflammation.

Previous reviews

Several reviews have been conducted on the efficacy of manual flossing, flossing aids and devices, and other interproximal cleansing aids (see table 1).^{1,9,34} However, few reviews are systematic or provide the methodology used by the review, and as of yet the Cochrane Collaboration has not conducted a meta-analysis. These reviews, dating as recently as 2004, consistently report that toothbrushing is insufficient for interdental cleansing.^{9,34}

Table 1. Summary of review papers

Review paper	Topic	Floss	Other aids	Concluding remarks
Warren PR et al.⁹ An overview of established interdental cleaning methods. <i>J Clin Dent.</i> 1996 ;7(3 Spec No): 65-69	Established interdental cleaning methods	Difficult to do, thus low compliance; claims to damage junctional epithelium; less effective in patients with attachment loss	Embrasure dependent; more effective than toothbrushing alone; may be easier to use than floss; results are equivocal	Interproximal cleaning success depends on ease of use and patient motivation; all interproximal devices appear to be effective, but each is suited to particular patient and situation within the mouth; each patient must be assessed individually
Brothwell DJ et al.³⁴ An update of mechanical oral hygiene practices: evidence-based recommendations for disease prevention. <i>J Can Dent Assoc.</i> 1998 ;64(4):295-306	Mechanical oral hygiene practices update	Optimal frequency not determined; less effective as recession increases and interdental spaces enlarge; no differences between flosses; more effective than toothbrushing alone in controlling gingivitis in adults	No differences between interproximal aids and no additional benefit to flossing	Updates a 1986 state of the science review on mechanical oral hygiene practices; recommends reviewing effects beyond plaque removal—only an intermediate outcome; a single superior interproximal device has not been identified
Jahn C.¹ Evidence for self-care products: power brushing and interdental aids. <i>J Pract Hyg.</i> 2004 ;13(1):24-29	Self-care products: power tooth brushes and interdental aids	Practitioners often perceive floss as superior to other methods, but this perception was not shown to be true	Floss holders, interdental brushes, power flossers have all demonstrated ability to remove plaque and reduce inflammation the same as manual flossing; many individuals preferred the alternatives	No systematic reviews exist on interdental aids, but literature reviews have been conducted. Whether an interproximal aid is effective ultimately hinges on whether the individual uses it or not

A Canadian systematic review (Brothwell et al., 1998) used the findings of the 1986 State-of-the-Science Workshop of the National Institute of Dental Research Conference on mechanical oral hygiene practices as a departure point for their update.³⁴ The 1986 review reported that interdental cleansing was required to supplement toothbrushing.³⁴ The 1998 update, which focused on studies that evaluated disease outcomes and that were published up until 1995, found no difference between floss types. It concluded that using the levels of evidence developed by the Canadian Task Force on the Periodic Health Examination, there was level I evidence to support flossing as “more effective than toothbrushing alone in controlling gingivitis in adults” and level II evidence that flossing was “more effective than toothbrushing alone in controlling periodontitis.”³⁴ Based on these findings, it was concluded that there was good evidence to recommend flossing in addition to toothbrushing for controlling gingivitis in adults.³⁴

Even in a cohort of health professionals, including dentists, fewer than two-thirds flossed daily.

The report also showed there was a moderate level of evidence to recommend, for the adult population, personal home water irrigation devices for controlling gingivitis and that wooden interdental cleansers provided an adjunctive affect to toothbrushing.³⁴ However, the review found that interdental brushes and gingival massagers were no more effective than toothbrushing alone in reducing gingivitis and therefore concluded that moderate evidence exists not to recommend these methods.³⁴

It was reported that most oral health practitioners favour flossing as an interdental cleanser, believing it to be superior to other methods under all conditions.¹ However, according to the review, this has not been demonstrated.¹ At proximal sites where recession has occurred, rendering a larger interdental space, floss is less effective than some other methods.^{9,34}

The most recent review (Jahn, 2004) concluded that floss holders, interproximal brushes, and power flossers had all demonstrated plaque-removal ability and reduction of gingival inflammation to the same degree as manual flossing. This review noted that many individuals preferred these alternatives.¹

The effect of health behaviours on oral health status

Health behaviours are defined as those activities performed by individuals in order to protect, maintain, or promote one’s health.^{10,35} Several cross-sectional and longitudinal studies have been conducted evaluating the relationship between oral hygiene practices and behaviours and oral disease and tooth retention.^{5,11,17,29,30,35-37} The aim of these studies is often to identify both risk indicators, described as those factors associated with disease

experience that may play a causal role in the disease process, and risk markers, which are not necessarily causally related to the disease process but can aid in identifying high-risk groups for oral disease.^{36,38} These studies can play a role in how oral health professions, including dental hygiene, devise strategies for improving the oral health of individuals, communities, and populations.

These studies confirm that flossing as a preventive oral health behaviour is used much less widely than toothbrushing in all examined populations.^{17,29,30,35-37} Even in a cohort of health professionals, including dentists, fewer than two-thirds flossed daily.¹¹ Results regarding the association between flossing and periodontal disease measures have been mixed. Some of these studies indicate that behavioural factors including flossing were associated with reduced periodontal disease,^{17,36,37} and more specifically, that more frequent flossing was associated with less attachment loss.^{17,36,37}

Conversely, other studies, including the health professionals’ study, showed that those who flossed more than once daily were as likely to have periodontal disease as those who flossed less than once a day.¹¹ Findings were similar for other oral hygiene aids, even when the analysis controlled for other confounders.¹¹ However, the study did show that this population had better oral hygiene practices than general populations and better overall oral health status.¹¹

MATERIALS AND METHODS

This position paper, commissioned by the CDHA, is a comprehensive review and critical analysis of the literature focused on dental flossing in order to develop a position statement on the use of dental flossing as a preventive oral health behaviour. The first step in the investigation was to develop a PICO question, which subsequently guided the literature search and the development of this report. The question is: Do adults who have plaque and/or gingivitis and/or early periodontitis (the Population) who manually finger floss (the Intervention) compared to using other flossing aids or interproximal cleansers (the Comparison) have improved plaque, bleeding, and/or gingivitis scores (Outcome)?

The literature search was conducted in stages beginning in November 2005 up to January 20, 2006. The search included the following databases: MedLine, CINAHL (Cumulative Index of Nursing and Allied Health Literature), and the Cochrane Controlled Trials Register. The literature search included all relevant papers including randomized controlled trials (RCT) (including both in vivo and in vitro studies), meta-analysis/systematic reviews, reviews, and various other sources including media reports and websites.

The first stage of the search was of the three databases and included combinations of the following keywords: floss, gingivitis, periodontitis, and plaque. The search was limited to articles written in English over the period from 1995 to 2005. This search resulted in 207 articles from the MedLine and CINAHL databases; the search of the Cochrane database did not produce any literature pertain-

ing to flossing (existing systematic reviews or study protocols). Papers were selected for retrieval if they measured the impact of flossing compared with another mechanical interproximal intervention in adult populations who had either plaque, and/or gingivitis, or early periodontitis and an outcome variable was measured, such as plaque, bleeding or gingival indices. Other relevant literature was identified at this point if it was deemed to provide background information. This selection process was conducted using titles, abstracts, and the full text if necessary. A total of 72 papers were identified and subsequently retrieved in full text. The second stage of the search used all papers found in the initial search and involved manually checking their bibliographies and references for additional pertinent materials. Retrieval criteria at the second stage were more purposeful and less restricted to the original keywords and the PICO question as the literature may have been necessary for further understanding or background information. Several websites were also subsequently examined.

A unique element of a position paper is the solicited input from recognized content experts and researchers. For this paper, expert input was sought from within the fields of periodontology and oral biology. The rationale for this combination was to provide expertise in each scientific theme of inquiry pertaining to this topic. A draft of this paper was then available for comment via the CDHA website. Additional input was solicited from targeted individuals and organizations, and appropriate revisions were made.

RESULTS

Floss types, comparisons

The literature available prior to 2000 did not reveal show that one specific floss type was superior to others.^{5,39-41} In a study conducted in 2000, four types of floss were compared: woven, waxed, unwaxed, and shred-resistant.⁵ This was a well-designed study, although it had a small sample size consisting of dental hygiene students as study subjects. A potential limitation of the study was that it considered plaque removal from each floss type on only one occasion, which took place after three days of plaque accumulation.⁵

The study measured total, anterior, and posterior interproximal plaque scores, and none of the scores for the floss types were significantly different among these sites.⁵ The study also evaluated comfort and time and neither of these resulted in significant findings between floss types. The authors concluded that all floss types were equally effective in plaque removal under these controlled conditions and all cleaned anterior regions better than posterior regions.⁵ Overall, the study demonstrated only 65% plaque reductions among the four types of floss.⁵ While not statistically significant, it was reported that unwaxed floss received the most negative feedback from the study subjects.⁵

Floss compared with floss aids or devices (see table 2)

Not only is manual or “finger” flossing being utilized by a relatively small proportion of adults, but even when it is

being used, studies have shown that the technique is often suboptimal. In one study, approximately 40% of the study subjects were found not to be using proper flossing technique.¹⁸ This finding has implications for the plaque removal efficacy of flossing. At least in part for these reasons, floss aids and automated flossing devices have been developed.

Prior to the mid-1990s, few clinical trials were conducted that compared flossing to flossing aids,⁴ but those that had been carried out suggested that floss-holding devices were as effective as manual or hand-held flossing methods.^{21,22} One RCT compared toothbrushing and the use of a disposable plastic pre-threaded floss holder with unwaxed floss with toothbrushing and manual finger flossing on plaque and gingival outcome measures.²² Thirty-five subjects took part in this well-designed cross-over study.²² The results demonstrated no significant difference between the groups in bleeding, plaque, or gingival indices.²² Although there were no significant differences between the two groups for preference and compliance measures, open-ended questions revealed a preference for the floss holder.²²

It was noted, however, that the floss-holding device was preferred to the manual method.

A subsequent cross-over study (Carter-Hanson et al., 1996) involving 30 adults compared the use of manual flossing to another manual floss holder device and measured plaque removal, bleeding and gingival response, safety, and study subject satisfaction.⁴ All clinical outcome measures, plaque, bleeding and gingival indices, showed significant improvements but again there were no significant differences between the test and the manual floss group.⁴ There was no apparent trauma in either group and no difference in satisfaction between the two methods.⁴ It was noted, however, that the floss-holding device was preferred to the manual method.⁴

Studies in the last decade have shown similar results in that the use of flossing aids and devices does not have a negative impact on plaque and gingival outcome scores as compared to manual finger flossing. In the mid-1990s, toothbrushing and manual finger flossing were compared with toothbrushing and an automated flossing device over six weeks (Pucher et al., 1995).²¹ The first phase of the study used dental students, while the second used periodontal maintenance clients. In both phases of the study, both groups had significant decreases in plaque and gingival scores, and between-group scores were not significantly different.²¹ The investigators found no evidence of damage to the tissues from either of the two methods and concluded that the flossing device was as effective as manual flossing.²¹ While no statistical test was conducted, the study subjects reported the flossing device to be helpful and preferred it.²¹

A similar study (Anderson et al., 1995) compared manual toothbrushing and finger flossing with toothbrushing and an electromechanical flossing device in a RCT involving 60 adult subjects measuring plaque and gingival scores over 30 days.²⁶ Again, both groups showed significant reductions in plaque and gingival indices from baseline, and there were no significant differences between groups.²⁶ Interestingly, in the test group, three subjects had to drop out of the study because of mechanical malfunctions with the floss device.²⁶ The investigators concluded that the floss device was as effective as manual

flossing in reducing plaque and gingival scores and no soft tissue trauma was detected in either group.²⁶

A more recent RCT (Shibley et al., 2001) compared an automated floss device to manual flossing in a 30-day study of 70 subjects using bleeding, plaque, and gingival indices along with comfort and preference indices as outcome measures.²⁴ Consistent findings again emerged from this study with all three clinical measures improving significantly from baseline scores, with no differences evident in outcome measures between groups.²⁴ The comfort index also showed no difference between groups, whereas the preference index showed an inclination for the power flosser, but this finding was not tested for significance.²⁴

Table 2. Summary of floss and floss aid studies

Study	Description	Design	Purpose	Outcome measures	Results
Anderson NA et al. ²⁶ Clinical comparison of the efficacy of an electromechanical flossing device or manual flossing in affecting interproximal gingival bleeding and plaque accumulation. <i>J Clin Dent.</i> 1995 ; 6:105-7	Manual TB + F vs. Manual TB + EMF (electromechanical flossing device)	RCT; n=60; 1 month	Compare the efficacy of EMF device to manual flossing	GI, PI	GI: within group improvements (p<0.0001); no difference between groups (p=0.91) PI: both groups improved (p<0.0001); no difference between groups (p=0.59)
Carter-Hanson C. et al. ⁴ Comparison of the plaque removal efficacy of a new flossing aid (Quik Floss®) to finger flossing. <i>J Clin Periodontol.</i> 1996 ; 23:873-8	Manual F vs. F device (Quik Floss®)	RCT; cross-over; n=29; 30 days	Evaluate the plaque removal, satisfaction, and safety of flossing device	PI, BI (Eastman), GI (Loe and Silness), trauma	PI, GI & BI: within group improvements (p<0.01); no differences between groups Trauma: none Satisfaction: none
Pucher J et al. ²¹ Clinical evaluation of a new flossing device. <i>Quint Int.</i> 1995 ;26:273-8	Manual TB + manual F vs. Manual TB + automatic flosser	RCT; 2 phase: n=36; n=26; 6 weeks	Evaluate the effectiveness of flossing device in plaque removal and reducing inflammation	MGI (Loe & Silness); MPI (Quigley-Hein)	GI & PI: within group improvements (p<0.0001); no differences between groups
Shibley O. et al. ²⁴ Clinical evaluation of an automatic flossing device vs. manual flossing. <i>J Clin Dent.</i> 2001 ;12(3):63-66	Manual F vs. Automated F (waterpik flosser)	RCT; n=70; 30 days	Compare the effectiveness of a powered flossing device to manual flossing	Eastman BI, PI, MGI & comfort index & preference	BI & MGI: within group improvements (p<0.01); no difference between groups; PI: within group improvements (p<0.01); manual outperformed power day 15 only (p=0.008); no difference day 30; Comfort: no difference between groups Preference: powered flosser (but not tested for significance)

TB = toothbrushing; F = flossing; GI = gingival index; PI = plaque index; MGI = modified gingival index

Floss compared with other interdental cleansing aids (see table 3)

While flossing has been shown to improve various outcome measures over toothbrushing alone, flossing has been shown to be less effective where there has been interdental recession with a subsequent increase in the interdental spaces.^{5,10,17,42} In these situations, other aids may be advantageous in reducing plaque and gingival scores. However, studies that have compared flossing to interdental cleansing aids have also been equivocal. For example, studies conducted prior to 1990 have shown that interdental aids are less effective in plaque removal than flossing.^{8,32} Conversely, later studies have demonstrated at least comparable efficacy from interproximal cleansing devices such as interdental brushes.²⁴ Other studies have

Where embrasures are wide, plaque removal was more efficient with interdental brushes than with floss.

shown that where embrasures are wide, plaque removal was more efficient with interdental brushes than with floss,¹⁹ possibly demonstrating a site-specific efficacy.

More recent studies have been conducted with the aim of further clarifying the efficacy of these methods. A 1996 study by Gordon et al. compared toothbrushing and manual flossing, and toothbrushing and cleaning with an electrically powered interdental device with a disposable rotating filament.³² This RCT included 52 early or middle-aged

Table 3. Summary of floss and other interdental cleansing aids studies

Study	Description	Design	Purpose	Outcome measures	Results
Gordon JM et al. ³² A clinical study of the safety and efficacy of a novel electric interdental cleaning device. <i>J Clin Dent.</i> 1996 ; 7:70-3	Manual TB + electrical powered cleaning device (Oral B interclean ID2) vs. Manual TB + F	RCT; cross-over; n=52; 4 weeks	Evaluate a new electrically powered interdental cleaning device that extrudes & rotates a small filament	MGI, PI & MPBI (interprox only); Preference	MGI, PI, MPBI: within group improvements (p<0.001); no difference between groups; Preference: majority preferred ID2 over floss (69.4%)
Cronin M. et al. ⁴³ The safety and efficacy of gingival massage with an electric interdental cleaning device. <i>J Clin Dent.</i> 1997 ; 8:130-3	Manual F vs. Electrical cleaning device (Oral-B InterClean ID2 –flexitip attachment)	RCT; n=59; 4 weeks	Compare the safety and efficacy of an electrical cleaning device	IPI, IGI, BI & safety	PI, GI, BI : within group improvements (p<0.0001); no difference between groups; Safety: no irritation in either group
Lewis MW et al. ⁸ Comparison of the use of a toothpick holder to dental floss in improvement of gingival health in humans. <i>J Periodont.</i> 2004 ; 75:551-6	Manual F vs. toothpick holder device (TP)	RCT; n=55; 2, 6, 12 weeks	Assess the ability of flossing or perio aid (toothpick in a handle) to reduce IP bleeding	Pocket depths, O’Leary PI, Eastman BI, IP PI,	PI, BI, IPI: within group improvements (p<0.05); no difference between groups
Barnes CM et al. ⁶ Comparison of irrigation to floss as an adjunct to toothbrushing. <i>J Clin Dent.</i> 2005 ;16:71-7	Manual TB + floss vs. Manual TB + Water Pik (WP) vs. Sonic TB (STB)+ WP	RCT; n=95; 14 & 28 days	Compare adding oral irrigation to brushing vs. brushing & flossing alone	IP BI, Loe & Silness GI, Proximal-Marginal PI	PI, BI & GI: within group improvements (p<0.05); (except TB + F group at 14 days); Between groups (at 4 weeks): BI & GI: Manual TB + WP & STB + WP outperformed Manual TB + floss (p<0.05) except for Li surfaces for GI; PI: STB + WP outperformed Manual TB + floss (p<0.05)

TB = toothbrushing; F = flossing; GI = gingival index; PI = plaque index; BI = bleeding index; MGI = modified gingival index

adult subjects over a four-week period and measured plaque, bleeding, and gingival outcomes.³² Results indicated that both groups had significantly improved values from baseline, and there were no differences between groups.³² The study assessed participant preference and found that the majority of participants (almost 70%) preferred the powered flossing device.³² The authors concluded that the product preference may encourage better compliance with interdental cleansing.³²

In the late 1990s, Cronin et al. compared manual flossing with an electrical gingival massager where plaque, bleeding and gingival indices, and safety were measured.⁴³ Previous studies had shown that the primary benefit of gingival massage was its plaque removal ability rather than the massaging action,^{43,44} and that such devices were at least as effective as flossing in reducing plaque, bleeding, and gingival scores.⁴⁴ Participants were excluded from the study if they presented with wide embrasures or advanced recession, suggesting that study subjects may have had a range of gingival conditions from none to moderate recession with some slightly open embrasures. Study subjects were assigned to either toothbrushing and manual dental floss or toothbrushing and the automated gingival massager group.⁴³ It was noted that two sizes of gingival massager tips were available for different sizes of interdental spaces. However, it is unclear if both sizes were used by study subjects. Results indicated that all three indices were significantly reduced from baseline values and no difference was detected between the groups.⁴³ Neither group demonstrated soft tissue irritation, and the authors concluded that both interventions were equally effective and safe.⁴³

Most dental hygienists primarily provide instruction in manual finger flossing techniques.

A recent 12-week RCT (Lewis et al., 2004) examined the effectiveness of manual toothbrushing and a toothpick holder compared with manual toothbrushing and flossing on subjects with gingivitis and early periodontitis.⁸ Outcome measures included plaque (whole mouth and interproximal) and interdental bleeding scores.⁸ No gingival indices were evaluated. Both plaque and bleeding scores significantly decreased for both groups, and again no difference was detected between groups.⁸ The authors concluded that their results, which were in conflict with previous studies, could be attributed to continuing reinforcement of the oral hygiene aid at the 2-, 6-, and 12-week follow-up appointments.⁸

Another recent study (Barnes et al., 2005) randomly assigned approximately 30 adult study subjects to one of three study groups: manual toothbrushing and flossing, manual toothbrushing and dental water jet, and sonic toothbrush and dental water jet for a period of almost one

month.⁶ Plaque, bleeding, and gingival indices were evaluated and demonstrated reduced values for all three groups at 28 days.⁶ At the four-week point, both of the dental water jet groups had significantly reduced bleeding and gingival scores compared with the manual flossing and toothbrushing group (except on lingual surfaces), and the sonic toothbrush combined with dental water jet group had significantly better plaque scores than the toothbrushing and flossing group.⁶ The investigators concluded that an effective alternative to flossing for reducing bleeding and gingival inflammation is combining home oral irrigation with toothbrushing.⁶

DISCUSSION

Dental hygienists justly continue to remain committed to motivating clients to regularly cleanse interdentally. While there is limited existing documentation of what dental hygienists recommend to their clients for oral hygiene home care methods, the literature suggests that most dental hygienists primarily provide instruction in manual finger flossing techniques.^{2,28} Studies have demonstrated that individuals who have established manual flossing habits are resistant to flossing aids or devices and remain loyal to their established methods.²⁸ One study has suggested that dental hygienists are situated within this group as they often develop a manual flossing habit during their dental hygiene education.²⁸ Subsequently, dental hygienists may develop and maintain a bias towards manual finger flossing. They therefore could have a predisposition to recommending this method of flossing to clients.²⁸ This has considerable implications for dental hygiene curriculum surrounding the education provided to clients of oral health behaviours.

Another study concluded that the oral hygiene instruction provided by dental hygienists does not appear to be adapted to individual and specific client needs. Even more disconcerting was the finding that one-third of the dental hygienists in these practice settings failed to perform any oral hygiene education.² This study confirmed that dental hygienists in this setting typically perform "traditional" oral hygiene instructional behaviours, meaning manual toothbrushing and finger flossing techniques, rather than incorporating alternative aids and devices when indicated.²

Oral health education is based on improving clients' knowledge and skills, which will ideally lead to improved behaviours.³ While some studies have shown that it is difficult to stimulate change in clients' oral health care behaviours, others have shown that it can be influenced and provoked.³ In one study examining the development of habitual flossing, it was demonstrated that six months after the initial study ended, 50% of the previous non-flossers were still flossing regularly.²⁸ Interestingly, and statistically significant, of those in this group, 85% were using the flossing aid to which they had been introduced during the study, whereas only 15% were using manual flossing techniques.²⁸

CONCLUSIONS

In light of the results of this comprehensive literature search and critical analysis, it is concluded that dental hygienists are well advised to make recommendations to clients supporting mechanical interdental cleansing as an adjunct to toothbrushing. While flossing with any type of floss is substantiated within this literature as an effective method of interproximal plaque removal, for some clients and/or for certain oral sites, other methods of interdental cleansing are warranted. Dental hygienists should be

aware of possible personal biases towards flossing, particularly manual finger flossing, and preferably make interproximal cleansing recommendations based on each client's oral condition, preference, and ability. In summary, the following six recommendations have been developed.

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RECOMMENDATIONS

1. Daily toothbrushing should continue to be augmented by some method of interdental cleansing in order to prevent, reduce, and reverse gingivitis in adults.
2. Daily flossing with almost any type of floss (if not all types) can be included as one possible interdental cleaning aid as an adjunct to toothbrushing.
3. Flossing should be recognized as having limitations in effectiveness in sites where recession/attachment loss and/or embrasure spaces have occurred.
4. Many flossing aids and interdental cleansers including floss holders, automated flossers, interdental brushes, picks, wooden sticks and some home irrigators, are viable alternatives to manual finger flossing.
5. Dental hygienists should be aware of personal biases towards "traditional" oral hygiene aids, such as flossing, and aim to be more receptive to other aids and mechanical alternatives.
6. Dental hygienists should tailor their oral hygiene education and instructions based on client/site-specific needs and preferences.

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