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# FLOSSING UNRAVELED: THE EVIDENCE ON INTERDENTAL CLEANING

Course : #20-33

## DISCLOSURE STATEMENT

- The content for this self-study course was written by Carol A. Jahn, RDH, MS, an employee of Water Pik, Inc.
- This course was designed, developed, and produced by Water Pik, Inc., a subsidiary of Church & Dwight, Inc.
- Water Pik, Inc., manufactures and distributes the products addressed in this course.

## AUDIENCE

This course is intended for dentists, dental hygienists, and dental assistants

## EDUCATIONAL METHOD

The educational method used is self-study. A post test must be submitted to receive credit.

## COURSE OBJECTIVE

To provide the learner with a scientific review of the numerous products available for interdental cleaning, which will enable dental professionals to recommend the product best suited for a person's individual needs, wants, abilities, and lifestyle.

## LEARNING OUTCOMES

- Explain the controversy surrounding string floss
- Understand what constitutes a systematic review and its role in evidence-based care
- Discuss the safety and evidence for string floss, interproximal brushes, wooden sticks, toothpicks, and a water flosser
- Recommend products based on individual patient need and ability

## INTRODUCTION

Brush and floss. It is a word duo as common as "bread and butter" and "salt and pepper." To say "brush and interdental cleaning" would sound as awkward as "bread and olive oil" or "herb and pepper." From a health perspective, people often choose olive oil over butter or another seasoning versus salt. Medical professionals even encourage it. Yet when it comes to recommending an alternative to string floss, dental professionals are sometimes reluctant and frequently feel guilty about suggesting a different product.

The universal recommendation for flossing was turned upside down on August 2, 2016, when Jeff Donn, a national writer with the Associated Press published an article stating the medical benefits of floss are unproven. More surprising, Donn uncovered information that the Federal Drug Administration had pulled daily flossing as a recommendation from its latest dietary guidelines; such guidelines have been in place since 1979.1 The report became the news story of the day, appearing all over the Web and on most local and national media broadcasts.

Anger. Shock. Disbelief. These were common emotions experienced by many dental professionals upon hearing the Donn story. More important was the deep concern that the overarching message was that brushing is "simply enough." Or his exposé, Donn focused on 25 studies, all a part of 4 systematic reviews.[2,3,4,5] However, upon examination, although these reviews did acknowledge the weakness of the studies on string floss, none went so far as to recommend abandoning the practice completely. Disappointingly, Donn omitted this.

Dental professionals see firsthand the oral health consequences that occur when people do not use floss or any interdental aid on a regular basis. People will state a variety of reasons about why they do not floss. In fact, a study from the American Academy of Periodontology found that nearly 25% of adults lie about flossing and would rather do an unpleasant activity than floss.6 The reality is that string floss is challenging for many people so they simply don't do it. The good news is that for those resistant to flossing or who simply cannot master the skill, there are many proven, effective alternatives.

## THE BASIS FOR THE NEWS REPORT: SYSTEMATIC REVIEWS

After the news report, dental professionals were curious to learn about the 25 studies Donn had examined. What made the job easy for him was that these studies had already been reviewed and were part of 4 systematic reviews. **Figure 1.** These papers evaluated and analyzed the data on floss pertaining to gingivitis, caries, or both and had concluded the evidence for its benefit was weak.[1,2,3,4,5] Donn only reported the findings from the systematic reviews; he did not draw his own conclusions.

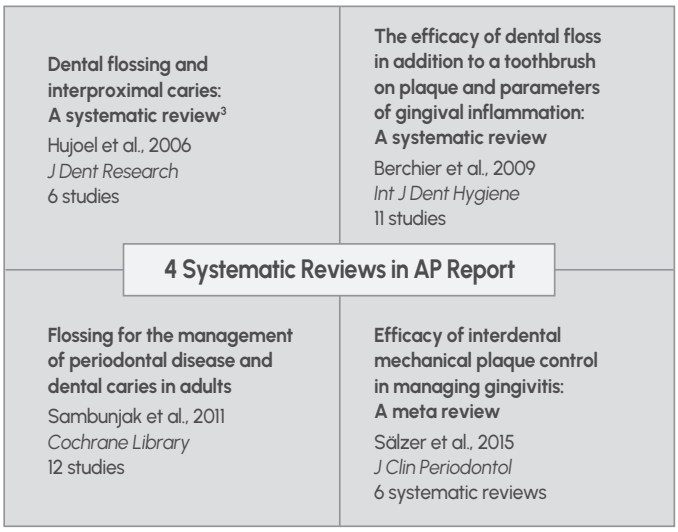



Figure 1: Four Systematic Reviews in the AP Report

The systematic review emerged with the advent of evidence-based health care. It is now viewed as the gold standard in helping practitioners identity health care interventions with the best or most reliable outcome.[7] The systematic review combines the results from multiple studies and can provide a higher level of confidence in outcomes than can be found with a single

study. This type of review started in medicine and is common in dentistry and other fields, including education and social/behavioral sciences. There are nonprofit groups solely dedicated to the development of systematic reviews. In health care, the most recognized and respected is Cochrane, a global network that gathers and summarizes the best evidence from research to help people, practitioners and patients, make informed choices about healthcare treatment.[8]

A systematic review is different from a traditional literature review because it has a definitive, focused scientific approach. It is a rigorous and time-consuming process that requires a minimum of 2 people to reduce the risk of bias. It employs an explicit method to how studies are located, reviewed, and selected for inclusion in the review. Data from all included studies is extracted and synthesized so that the conclusion can give clinicians the most reliable evidence possible about a therapy, test, or treatment.[7]

The systematic review sits at the top of the "hierarchy of evidence". **Figure 2.** Like any research study, a systematic review can have limitations. The review must follow specific protocols. If the review is not executed according to a set procedure, the results could be called into question. Conversely, the most well-conducted review will have limited usefulness if the evidence included is of poor quality.[7] A systematic review can also uncover areas where there is limited evidence and/or more evidence is needed.[7]

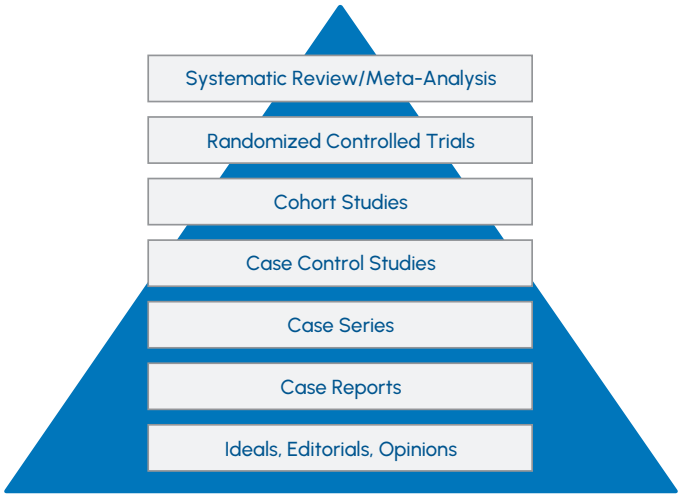



Figure 2: Hierarchy of Evidence

A systematic review does not mean that the results from randomized controlled trials (RCTs) are not important. In the case of interdental aids, there are products that have not been evaluated via a systematic review. In other cases, additional research and findings from RCTs may have occurred post-review. Another limitation is included studies on obsoleted products. The publication dates from the systematic reviews Donn covered range from 2006 to 2015.[2-5] The 2015 meta-review includes several reviews from 2008.[5]

## THE EVIDENCE ON STRING FLOSS

Dental floss has been on the market since the late 1800s. **Figure 3**. Dental professionals have often been taught that it is the 'gold standard' for reducing gingivitis and preventing periodontal disease and dental caries. Thus, it has also been assumed by most that string floss is superior to all other interdental aids. Yet dental floss has not been subject to the same type of scientific scrutiny that a product or drug introduced today would undergo. Although an absence of evidence does not mean a product is ineffective, it does mean that some long-standing assumptions about string floss are not grounded in scientific findings.

A 2-week study with 119 subjects published in 1989 by Graves et al. found that people who added daily string flossing to toothbrushing over a 2-week period reduced bleeding by 67% compared to 35% for brushing alone. Three different types of floss were used: waxed, unwaxed, and tape. The bleeding reductions were similar for all products. Flossing was carried out under controlled circumstances, with subjects returning to the study center each weekday for supervised flossing. The study examiners did not participate in the daily instruction.

The results from Graves et al. provide data that flossing can be effective when done routinely under ideal conditions. However, the standard today when evaluating self-care products is a minimum duration of 4 weeks, plus unsupervised use by a typical patient.[2,3] This methodology allows the element of human behavior to factor into the study. Although this may seem counterintuitive, the effectiveness of a product is best determined when it is used under real-life circumstances. A product will not live up to its potential if it is too difficult to use or people fail to use it regularly or at a level that can attain a health benefit.

For plaque and gingivitis, Donn focused on the studies of Berchier et al.2 and Sambunjak et al.[4] Berchier et al. included 11 studies with 559 subjects. Study length ranged from 4 weeks to 6 months. All subjects were at least 18 years of age. When reviewing the addition of floss to toothbrushing, the investigators found weak evidence. Out of 11 studies, 3 supported better plaque removal, 1 demonstrated a better bleeding reduction, and 1 showed a greater reduction in gingivitis.[2]

The Sambunjak et al. systematic review on flossing was conducted under the auspices of the Cochrane group. Twelve articles with 1,083 subjects were reviewed; 7 of the articles were part of the Berchier et al. review.[5] This investigative team found there was some weak evidence from the 12 studies reviewed that adding floss to toothbrushing reduced gingivitis. Ten studies focused on plaque removal, and the reviewers concluded there was weak, unreliable evidence to support better plaque reductions.[4]

For caries, Donn included the studies of Sambunjak et al.[4] and Hujoel et al.[3] The Cochrane review searched for studies on the reduction of dental caries in adults. After an extensive quest, they determined there are no studies published that report on the effectiveness of caries reduction via brushing and flossing.[4] Likewise, Hujoel et al. conducted a systematic review on flossing and caries reduction. His team located 6 studies. The subjects were 808 children ages 4–13 years. No studies were found on adults. One of the studies reviewed showed that in children with primary teeth, poor oral hygiene, and minimal fluoride exposure, professional flossing at school over a 1.7-year period resulted in a 40% reduction in caries. However, they found

a different result from a study conducted over a 2-year time frame with adolescents who self-performed flossing and had adequate exposure to fluoride. In this case, the results indicated that flossing did not reduce the risk of caries.[3]

Despite the dismal results of these systematic reviews, it is important to note that none of the investigative teams concluded that flossing should be abandoned. Berchier et al. noted that the routine recommendation for flossing was not supported by strong evidence, and that the dental professional needed to determine on an individual basis whether flossing is an achievable goal.4 The findings of Hujoel et al. are similar. They concluded that dental professionals should determine on an individual patient basis whether "professional quality" flossing is an achievable goal.[3] The Cochrane group appears to agree by saying, "Despite the uncertain or low quality of most studies, and given the importance of avoiding plaque deposition, plus the absence of major disadvantages, these results support the use of flossing with toothbrushing."[4]

## STRING FLOSS AND PREVENTION OF CARIES AND PERIODONTAL DISEASE

It is surprising to both dental professionals and the public that few studies have been conducted on flossing and dental caries. However, it is more challenging to conduct a study to show a reduced risk of caries than to prove gingivitis reduction. Gingivitis is experienced by over 90% of adults, providing a large, easy pool of subjects.[10] Gingivitis can be resolved quickly through good plaque removal so outcomes can be assessed in a short time frame. In comparison, the pool of adults at high risk for interproximal caries is smaller. Although over 90% of adults have experienced decay during their lifetime, data from the 2010–2011 National Health and Nutrition Examination Survey (NHANES) reported 27% with untreated decay.[11] Most gingivitis is plaque induced, but caries tend to be multifactorial. Thus, a study would need to take other risk factors such as fluoride exposure or sugar consumption into account. A longer study time such as 2 years would be needed to show a benefit. Because caries can be prevented and arrested, there may be ethical considerations to consider as well.

Long-term studies are needed to show that flossing can prevent periodontal disease. It is widely accepted by most dental professionals that gingivitis is a precursor to periodontal disease. Common sense says that preventing gingivitis will prevent periodontal disease. Yet not all periodontitis is due to poor plaque control. It is well-established that smoking is a primary risk factor for the disease.

A cross-sectional study published in the *Journal of Clinical Periodontology* used NHANES data from the years 2011–2014 to assess the association of flossing with periodontitis.[12] A total of 6,939 subjects 30 years of age or older answered a question about flossing frequency and underwent a periodontal exam. The results found that those who stated they flossed at least once a week had a 17% lower risk of periodontal disease. However, when the investigators considered age, gender, smoking, frequency of dental visits, and income with periodontal disease, these modifiers were substantially stronger in predicting periodontal disease than was the protective benefit from flossing. They also found there was no dose-response benefit from flossing; in other words, greater flossing frequency did not result in better protection from periodontitis. The investigators noted this could have resulted from people's lack of ability to floss effectively.[12] Crocombe et al. had similar findings in a 2012 study of data from the National Survey of Oral Health 2004–2006. Regular interdental cleaning was associated with better oral hygiene outcomes; however, there was no association with attachment loss.[13]

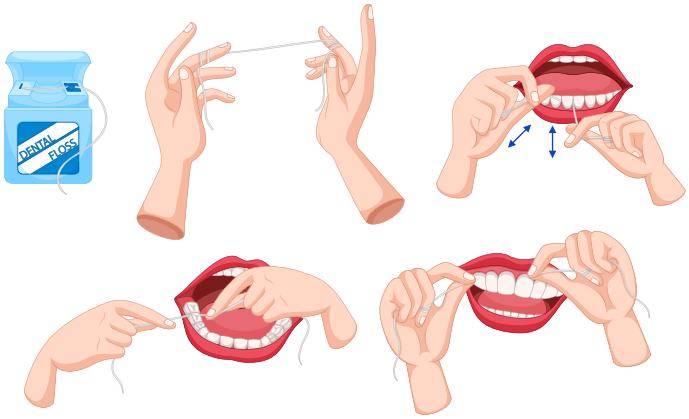



Figure 3: String Flossing Skills

Flossing is a skill not easily mastered by those who are not dental professionals **(see Figure 3)**. Lang et al. looked at typical brushing and flossing habits of people in the Detroit area. They found that although over 95% of people reported brushing at least once a day, around 33% reported flossing daily. When the investigators looked at the number of people who could perform acceptable flossing skills **(Table 1)**, the number dropped to 22%.[14] This inability to perform flossing at a level high enough to produce a health benefit is likely the biggest factor behind the weak evidence on flossing for plaque and gingivitis reductions. When done well and regularly, flossing works. The reality is that it does not work for most people because of a lack of expertise and/or motivation.[14]

| Table 2: Flossing Skills Evaluated by Lang et al.14 |
|---|
| · Holds floss firmly |
| · Eases floss through the contact point |
| · Pushes the floss subgingivally |
| · Wraps floss around the line angles |
| · Moves floss vertically against the tooth |

## THE EVIDENCE FOR ALTERNATIVES TO STRING FLOSS

The fourth paper cited in the Donn report was a meta-review of 6 systematic reviews by Sältzer et al.5 The focus of the meta-review was the effect of interdental plaque removal along with toothbrushing on managing gingivitis using various types of interdental aids.[5] The 2 reviews by Berchier et al.[2] and Sambunjak et al.4 were included. Reviews on interdental

***Patient compliance and preferences should be considered when recommending any interdental cleaning device, including interdental brushes, floss, wooden sticks, or oral irrigators.[15]***

brushes, wooden sticks, and oral irrigators[5] were also evaluated. The investigators concluded that of the products reviewed, interdental brushes provided the best evidence for plaque removal. The evidence was deemed weak for the other products in relation to plaque. However, the reviewers noted that all devices studied seem to support use for the management of gingivitis.[5] It is noteworthy that Donn also omits this information from his article.[1]

Saltmarsh and Frantsve-Hawley reviewed Sältzer et al. and agreed that the interdental brush may be a good choice for personal oral hygiene; however, they cautioned that the individual's oral anatomy must allow for the use of the tool without providing trauma. Likewise, they found that each product in the review might be of some benefit in reducing gingivitis. They noted that flossing could also be a part of a home care regime as long as the patient has the skills and motivation to use the product effectively. Patient compliance and preferences should be considered when recommending any interdental cleaning device, including interdental brushes, floss, wooden sticks, or oral irrigators.[15]

## INTERDENTAL BRUSHES

Floss may be boss in North American but for many Europeans, interdental brushes (IDB) are the preferred tool for interdental cleaning. **Figure 4.** The IDB can be cone or cylindrical shaped. They come in a variety of widths to accommodate different embrasure sizes. **Figure 5.** Conventional wisdom assumes that for periodontal maintenance patients, the IDB may be more effective at removing plaque than string floss. For many people, these types of brushes are easier and more convenient to use than string floss.

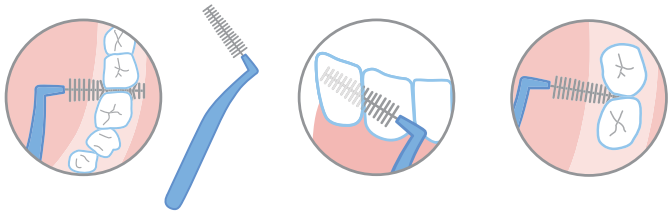


Figure 4: Interdental Brushes

Figure 5: Interdental Brush Sizes and Shapes

A 2008 systematic review by Slot et al. analyzed the data from 9 studies with 510 total subjects to determine the efficacy of the IDB on plaque and periodontal inflammation. Duration of the studies ranged from 4–12 weeks. The studies varied in design and product comparison (flossing or wooden sticks). The studies used a wide variety of IDB product brands, sizes, shapes, and lengths. Most investigations used periodontal maintenance patients for the study population.[16]

The researchers concluded that the IDB used with manual toothbrushing removed more plaque than brushing alone. However, the evidence was inconclusive for the effect on gingival inflammation. The IDB was found to remove more plaque than dental floss or wooden sticks. Reduction in gingival inflammation was similar for floss and the IDB. Pocket depth reduction was more pronounced with the IDB versus string floss. Three studies in the review evaluated patient preference and found patients preferred the IDB to string floss and found it less time consuming.[16]

A 2013 Cochrane review by Poklepovic et al. evaluated the IDB for the prevention and control of periodontal diseases and dental caries in adults. Seven studies with 354 subjects were included in the analysis. All the studies included a comparison to toothbrushing and flossing. One study included a comparison to toothbrushing only. No other products were included. None of the studies reviewed reported on dental caries.[17] The results from the Cochrane review found insufficient evidence to determine whether an IDB reduced or increased levels of plaque when compared to flossing. Regarding gingivitis, there was low-quality evidence that the IDB provided better gingivitis reduction than flossing.[17]

IDBs come in a variety of shapes and sizes. A 2016 study with 51 participants compared conically shaped to cylindrically shaped IDBs. The results showed that conical IDBs were less effective at removing lingual approximal plaque than cylindrical IDBs.[18] A 6-week 2006 study with 120 subjects compared 4 interdental products: dental floss, a flosser, an IDB, and a small interdental cleaner with elastomeric fingers. The investigators found that all products performed comparably for plaque reduction and bleeding. The IDB provided a statistically significant improvement for gingivitis on the buccal versus the other products.[19]

## WOODEN STICKS AND TOOTHPICKS

Using a wooden stick to clean between teeth is one of the oldest forms of interdental cleaning. Triangular wooden sticks made from soft wood, as well as toothpicks, remain a popular tool with people across the globe. The wooden stick is liked by dental professionals because its triangular configuration allows for easy access into open embrasure areas. **Figure 6.** For toothpicks, they are generally recommended for use with a holder that allows the toothpick to be broken off to an acceptable length and used at a proper angle. **Figure 7.**

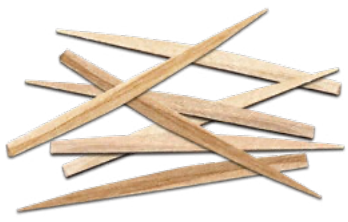


Figure 6: Triangular Wooden Sticks

Figure 7: Toothpicks

There is a paucity of research on triangular wooden sticks and toothpicks. A 2008 systematic review by Hoenderdos et al. analyzed 8 studies among 7 papers (one study included 2 experiments). Publication dates for the 7 studies ranged from 1970–1993. There were 438 subjects total. The study periods ranged from 3 weeks to 3.5 months. The studies used different product comparisons: toothbrushing only, toothbrushing and floss, and interdental brushes. The analysis found that wooden sticks did not provide better plaque removal than the other products. Use of the wooden stick did result in a greater reduction in bleeding.[20]

A 2004 *Journal of Periodontology* study compared the use of a toothpick in a holder to dental floss. At 12 weeks, both the toothpick in a holder and string floss significantly reduced overall plaque, interproximal plaque, and bleeding.[21] Although dental professionals sometimes assume that triangular wooden sticks are better than a toothpick,[20] a single-use plaque study found both products provided similar levels of plaque removal.[22] A comparison of dental floss, IDBs, and toothpicks found the largest plaque reduction with IDBs (83%) followed by toothpicks (74%) and dental floss (73%). The study also found that subjects under the age of 40 preferred dental floss, whereas those over 40 liked IDBs.[23]

## FLOSS HOLDERS, RUBBER TIP STIMULATORS, AND END-TUFT BRUSHES

A visitor to the oral care department in a pharmacy, discount retailer, or online company will quickly find a large number of oral care products. Some products such as rubber tip stimulators have been around for years. **Figure 8.** In other cases, many single-use floss holders have been modified to include a flexible pick for cleaning between teeth. **Figure 9.** Little evidence exists on these alternative products.

Figure 8: Rubber Tip Stimulator

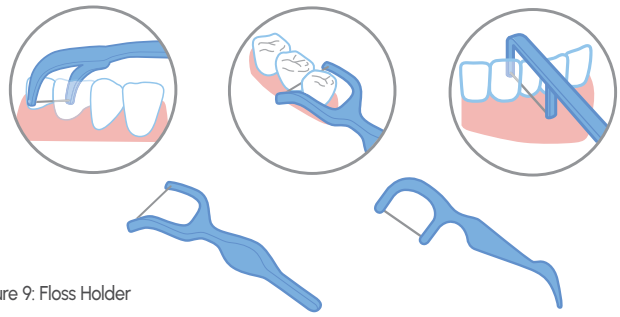


Figure 9: Floss Holder

The floss holder has been reviewed in clinical trials and found to provide improvements in oral health similar to string floss.[24,25] A 1990 *Journal of Dental Hygiene* study employed a crossover design so that each subject used string floss during 1 study period and the floss holder during the other study period. The results found that both products were equally successful in removing plaque and reducing gingivitis. The subjects were surveyed about preference, and 70% preferred the floss holder. Six months later, the subjects were sent another survey to determine how many had developed a flossing habit. Fifty percent of non-flossers had begun flossing; 85% of those were using a floss holder.[24] Spolsky et al. also found those using floss or a flossing aid had similar plaque and gingivitis reductions. Fifty-six percent preferred the flossing aid.[25]

The rubber tip stimulator is often recommended for gingival massage and/or plaque removal. It has rarely been clinically evaluated. A 1987 split mouth design study compared the rubber tip to dental floss and an IDB to toothbrushing alone. The results found that all the products enhanced plaque removal but did not reduce gingivitis better than toothbrushing.[26]

A 2011 single-use plaque study looked at the difference between an end-tuft brush **(Figure 10)** and a flat-trimmed brush. Participants used each product in a crossover sequence. The results showed that the end-tuft brush removed 44% more plaque from the maxillary buccal interproximal area and 8% more from the marginal and mandibular lingual interproximal sites. For the other areas of the mouth, there were no significant differences. Five patients experienced gingival abrasion from the end-tuft brush.[27]

Figure 10: End-Tuft Brush

## ORAL IRRIGATORS/ WATER FLOSSERS

One of the first oral irrigators, now called a water flosser, was introduced in 1962. Many of the early investors in the product were dentists. Nearly 60 years after its inception, the water flosser is backed by 75 research studies—more than flossing and most other interdental products combined. In 2017, the Waterpik™ water flosser was awarded the American Dental Association Seal of Acceptance for plaque removal along the gumline and between teeth as well as for helping to prevent

ADA Accepted
American Dental Association ®

Figure 11, 12, 13: Waterpik™ Aquarius™ Professional water flosser, Waterpik™ Cordless Advanced water flosser and ADA Seal of Acceptance

and reduce gingivitis. It is the first powered interdental cleaner to earn the seal. **Figures 11, 12, 13.**

A systematic review of oral irrigation by Husseini et al. was published in 2008. The review included 7 studies with devices of different brands, some of which had not been on the market for many years. The results found that as an adjunct to toothbrushing, a water flosser did not provide an additional benefit in plaque reduction. The data did show that a water flosser had a beneficial effect on gingivitis, bleeding, and pocket depth. The investigators also looked at bacteremia and found that the bacteremia potential of a water flosser is similar to brushing, flossing, chewing, and scaling and root planing. Further, periodontal maintenance patients who used a water flosser daily for 3 months did not increase their risk of developing a bacteremia.[28]

Since the 2008 review by Husseini et al., 15 additional clinical studies have been conducted on the water flosser.[30-44] Five studies have compared the water flosser to string floss[29,30,32,36,38] and 2 studies have compared the water flosser to an IDB.[40,41] In each study, the water flosser has been shown to be significantly better in improving oral health.[30-34,36-38, 40,41,42]

Rosema et al. found that adding a water flosser to manual brushing was twice as effective as manual brushing and flossing at reducing bleeding.[32] Barnes et al. demonstrated that the addition of a water flosser was up to 93% better at reducing bleeding and up to 52% better at reducing gingivitis versus traditional dental floss.[29] **Figure 14.** Similarly, Sharma et al. and Magnusson et al. also found the water flosser produced significantly better improvements in oral health versus string floss.[30,38]

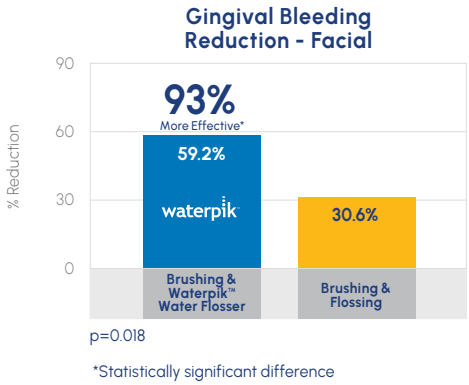
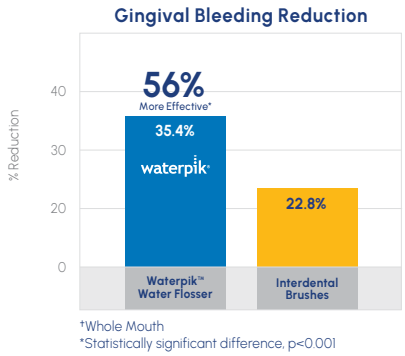



Figure 14: Barnes et al.[29] Reduction of gingival bleeding compared to string floss

A study of 28 subjects compared the use of the water flosser with the traditional jet tip **(Figure 15)** to the IDB over a 2-week period for plaque and bleeding on probing reduction. All subjects used a manual toothbrush. At the conclusion of the study, the water flosser was 56% more effective than an IDB at reducing bleeding upon probing. For plaque, both groups had significant reductions from baseline.[40] **Figure 16.** A single-use plaque study also compared the water flosser and IDB and found the water flosser was 20% more effective than the IDB at removing plaque.[41]

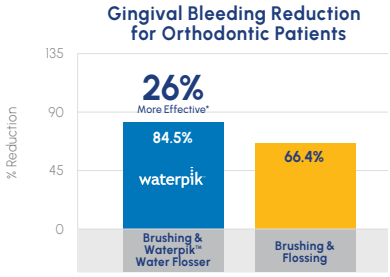
Figure 15: The Classic Jet Tip




†Whole Mouth
*Statistically significant difference, p<0.001

Figure 16: Goyal et al.[40] IDB compared to water flosser

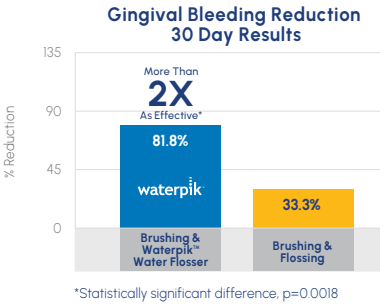
Figure 17: Orthodontic Tip




*Statistically significant difference, p<0.001
†Whole Mouth

Figure 18: Sharma et al.[31] Reduction of gingival inflammation versus string floss

Figure 19: Plaque Seeker™ Tip




*Statistically significant difference, p=0.0018

Figure 20: Magnusson et al.[38] Reduction of bleeding vs string floss with implants

The water flosser has been shown to be an ideal device for helping improve oral health in patients with orthodontic appliances[30] and implants.[38] A study of 106 adolescents 11–17 years of age compared manual toothbrushing plus a water flosser with a tip designed specifically for orthodontic appliances **(Figure 17)** to 2 other groups: manual toothbrushing plus flossing via a floss threader and manual toothbrushing alone. The results showed that the addition of a water flosser to toothbrushing reduced 3.76 times more plaque than flossing with a floss threader and 5.83 times more plaque than manual toothbrushing alone. A water flosser also provided significantly better reduction in bleeding: 84.5% from baseline. This was 26% better than the results achieved with dental floss[31] **(Figure 18).** Similarly, in a study of people with implants, Magnuson et al. found water flossing with a tip designed for implants **(Figure 19)** twice as effective as string floss at reducing bleeding over a 30-day period[38] **(Figure 20).**

Evidence indicates that a water flosser has the greatest potential of any self-care device for subgingival access into the periodontal pocket[46] **(Table 2.)** Studies documenting subgingival access in vivo for tooth brushing and flossing are limited. Conventional wisdom rather than scientific evidence says that toothbrushing typically reaches 1–2 millimeters and traditional dental floss up to 3 millimeters. A water flosser has been shown to disrupt bacteria up to 6 mm.[45]

Table 2: Depth of Delivery of Interdental Devices

| Product | Penetration | Comments |
|---|---|---|
| Water Flosser | 6 mm[42] | Disruption of bacteria up to 6 mm[42] |
| Toothpicks & Wooden Sticks | Depends on embrasure size | Effectiveness depends on sufficient interdental space |
| Interdental Brushes | Depends on embrasure size | Effectiveness depends on sufficient interdental space |
| Floss | 3 mm | Cannot access deeper pockets |

Many people are surprised to see the data demonstrating that the water flosser can remove plaque. A study conducted at the University of Southern California's Center for Biofilms evaluated the effect of shear hydraulic forces from water flossing on dental biofilm using scanning electron microscopy (SEM).[31] Eight teeth were extracted from a patient with advanced periodontal disease. Pretreatment SEM images of the teeth found they were colonized by a luxuriant biofilm appearing several micrometers thick **(Figure 21).** The teeth were water flossed for 3 seconds at a medium pressure (70 psi) setting. Posttreatment-SEM images found that water flossing removed up to 99.9% of plaque biofilm5. **Figure 22.** The researchers concluded that the shear hydraulic forces produced by a water flosser with 1,200–1,400 pulsations per minute at medium pressure could significantly remove biofilm from tooth surfaces.[31]

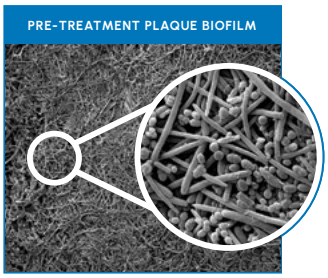



Figure 21: Gorur et al.5 Before treatment with the water flosser

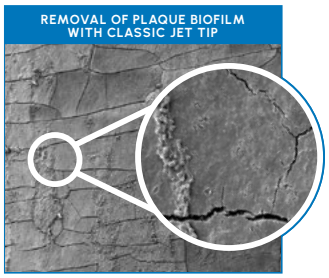



Figure 22: Gorur et al.5 Tooth surface after 3 second use with water flosser

The plaque biofilm-removing capabilities of the water flosser were further evaluated in a single-use study. Seventy adults abstained from all oral hygiene for 23–25 hours. The subjects rinsed with a red disclosing solution and then used a manual toothbrush and a water flosser or a manual toothbrush and dental floss. Standard brushing and flossing instructions were provided, as were directions for using the water flosser. The investigators found that the water-flossing group removed 74% of whole mouth plaque compared to 56% for those using string floss, making the water flosser 29% more effective.[36] The water flosser also removed nearly 82% of approximal plaque compared to 63% for string floss.[36] These findings are supported by Sharma et al., who found the water flosser removed 75% of whole mouth plaque and 92% of approximal plaque.[33]

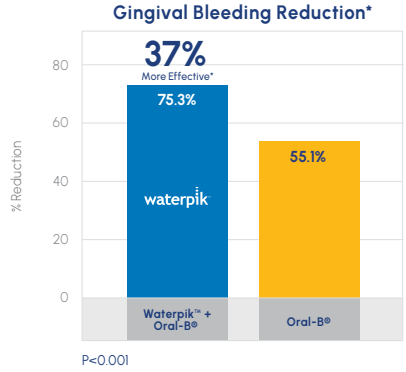



Figure 23: Goyal et al.[42] Water Flosser versus an oscillating power toothbrush

Whether patients use a power or manual toothbrush, adding a water flosser to the brushing routine has been shown to significantly improve oral health.[29,35,42,43,45] A 2020 study found that subjects who added a water flossing to brushing with a high-end oscillating toothbrush improved plaque reduction by 33%, and reduced gingival bleeding and inflammation by 37% and 36% respectively compared to only brushing with the oscillating device.[42] **Figure 23.** This supports work by Barnes et al.,[29] and Goyal et al.[35] Specifically, Barnes et al. found that the addition of a water flosser, once daily with water, to either manual or power brushing was a more effective alternative to string floss for the reduction of bleeding, gingivitis, and plaque.[29] Likewise, Goyal et al. found that adding a sonic toothbrush and a water flosser were more effective than sonic toothbrushing only for reducing bleeding, gingivitis, and plaque.[35] For patients who prefer a manual toothbrush, adding a water flosser to a manual brushing routine was found to be 3.1 times more effective at reducing bleeding on probing, 2.7 times more effective at reducing gingivitis, and 2.4 times more effective at reducing plaque versus manual brushing only.[43]

A newer entry to the self-care market is a flossing toothbrush that combines the power of a sonic toothbrush with the clinically proven efficacy of water flossing. **Figure 24.** This new tool allows patients to add water flossing to toothbrushing with the simple touch of a button. This brush has earned the ADA Seal of Acceptance.

A 4-week study found that the flossing toothbrush was twice as effective as string floss for removing plaque and reducing

Figure 24: Waterpik™ Sonic-Fusion™

bleeding and gingivitis.[14] **Figure 25.** The study included 105 subjects who were assigned to one of three groups; flossing toothbrush, a traditional sonic toothbrush, or manual brush and floss. All products were used twice daily, and instructions were provided by demonstration and verbally. Subjects were requested to brush for two minutes and those in the flossing brush group use the water flosser mode for one minute.[14]

At the 4-week conclusion of the study, the flossing toothbrush was significantly more effective at reducing bleeding, gingivitis, and plaque than both the standard sonic toothbrush and manual brushing and flossing.[45]

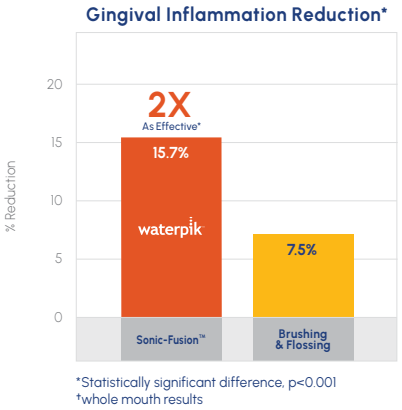



Figure 25: Goyal et al.[45] Waterpik™ Sonic-Fusion™ versus brushing and flossing

# PRODUCT SAFETY

In addition to efficacy, a primary concern of dental professionals is product safety. Dental floss, interdental brushes, and water flossers have been used by the public for decades. This practice in itself confers a level of safety. Although any product can be misused, the benefits generally outweigh the risks. Wise practitioners understand the value of trying for themselves the product they recommend, which is beneficial from both an instructional and credibility standpoint.

Patient instruction is needed for all interdental aids. Although an IDB is relatively easy to use compared to string floss, patients need direction regarding the brush size. Brushes that are too large for the embrasure area have the potential to cause trauma or abrasion. The same is true for triangular wooden sticks.

There have been numerous anecdotal stories told about the dangers of a water flosser. A 2018, six-week study by Goyal et al. debunks many of these myths.[47] One hundred and five (105) subjects were randomly assigned to 3 treatment groups; water flossing plus manual brushing, manual brushing and flossing, or manual brushing only. During the first two weeks of the study, those in the water flossing group gradually increased pressure up to 80 psi. During weeks 3 and 4, the subjects used the water flosser at 90 psi, and during weeks 5 and 6 at 100 psi. At the conclusion of the study, there were no adverse events reported in any of the groups. When assessing probing depth (PD) and clinical attachment levels (CAL), the water flossing group demonstrated better improvements in PD and CAL compared to brushing and flossing or brushing alone.[47] **Figure 26.** These results support the finding of a 2015 literature review on the safety of water flossing. The investigators found no data to support that it is detrimental to oral health and concluded that the water flosser is both safe and effective.[48]

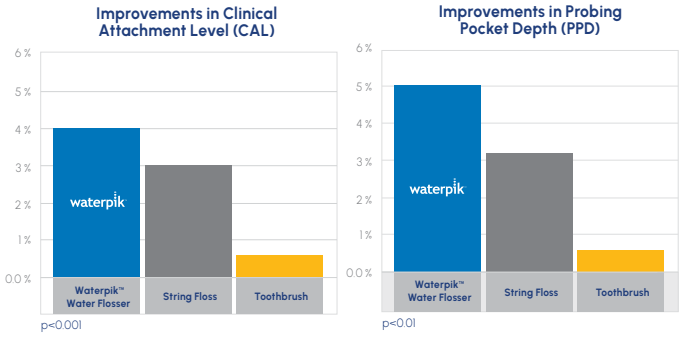



Figure 26: Goyal et al.[47]: Safety results on the water flosser

Improper flossing can cause damage to both the gingiva and the tooth.[49,50] Repeated snapping of floss through the contact or failing to wrap it around the tooth can result in floss cuts and or clefting.[49] A 2012 article in the *International Journal of Dental Hygiene* detailed the case of a man who developed an extensive linear notch-like defect at the distal cementoenamel junction of a maxillary molar related to years of aggressively sawing the dental floss around the tooth.[50]

In 2016, an observational study at the Academic Centre for Dentistry Amsterdam reported on 10 patients with progressive peri-implantitis. Flap surgery was undertaken, and in each situation, remnants of dental floss were found adhering to the roughened surface of the implant with peri-implantitis. The area was debrided, and 9 of 10 patients had significant improvements.[51] The investigators followed with in vitro testing and exposed a pristine implant to cleaning with dental floss. They found that floss left behind both fiber remnants and wax, leading the investigators to conclude that the use of dental floss may be a potential risk factor for peri-implantitis.[51]

# WHICH PRODUCT IS RIGHT FOR MY PATIENT?

The outcomes from the systematic reviews on the products most frequently recommended can cause doubt about the efficacy of any self-care product and confusion about recommendations. It can be puzzling to learn that a device removes plaque but does not improve gingivitis, or, even more baffling, to understand how it can improve gingivitis but not reduce plaque.

Keep in mind that science is a guide, not a solution. In a guest editorial that summarized several systematic reviews, including Berchier et al. on flossing,[2] Slot et al. on the IDB,[16] Hoenderdoes on wooden sticks,[20] and Husseini on oral irrigation,[28] Suvan and D'Aiuto[47] concluded:

***There is not one aid that works for all.***

***There is not one aid that does not work for anyone. Best care for each patient rests neither in clinical judgment nor scientific evidence but rather in the art of combining the two through interaction with the patient to find the best option for each individual.***[52]

Flossing is still a valid recommendation to make to patients who have both the dexterity and skill to do it at a level that improves their oral health. However, scientific evidence[2,3,4,5] and lack of patient interest in string floss,[6] suggest the days have passed when it should be recommended (often repeatedly) to everyone. There is no evidence to support the assumption that other products are less effective than string floss.[5] There is also no value in recommending an alternative product along with string floss. Patients are challenged to incorporate 2 home care devices, let alone a third. If patients are flossing without results, a better use of their time and energy is on a product that is easy for them to use and that produces results.

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## TO RECEIVE CREDIT, YOU MUST COMPLETE THE POST-TEST QUESTIONS ONLINE.

1. **Which statement is true about systematic reviews?**
   a. Gold standard of research
   b. Helps identify the best/most reliable health care outcomes
   c. Combines results from multiple studies
   d. All of the above

2. **Which statement is *not true* regarding standards for clinical research on home care products?**
   a. Study period should be a minimum of 12 weeks
   b. Product use must be unsupervised
   c. The subject should be considered an "typical patient"
   d. The product should be used under "real-life" circumstances

3. **Systematic reviews on flossing have found:**
   a. Strong evidence for plaque removal and gingivitis reductions
   b. Weak evidence for plaque removal and gingivitis reductions
   c. Strong evidence for plaque removal and weak evidence for gingivitis reductions
   d. Weak evidence for plaque removal and strong evidence for gingivitis reductions

4. **Why is it harder to show flossing reduces caries than gingivitis?**
   a. Caries is multifactorial
   b. Caries can be prevented and arrested
   c. Caries studies take longer
   d. All of the above

5. **Lang et al. found that around 33% of people have reported flossing daily; yet only _____ demonstrated acceptable flossing skills.**
   a. 31%
   b. 22%
   c. 14%
   d. 6%

6. **Which statement is true about interdental brushes?**
   a. Cylindrical brushes may be more effective than conical
   b. Patients must have adequate embrasure space
   c. Very popular in Europe
   d. All of the above

7. **Hoenderdoes et al. found that when compared to other products, triangular wooden sticks:**
   a. Provided better plaque removal and better bleeding reductions
   b. Provided better plaque removal but not better bleeding reductions
   c. Did not provide better plaque removal but did provide better bleeding reductions
   d. Did not provide better plaque removal or better bleeding reductions

8. **A comparison study of floss, interdental brushes, and toothpicks found:**
   a. Toothpicks removed the most plaque
   b. Floss removed the most plaque
   c. Those over 40 preferred string floss
   d. Those over 40 preferred interdental brushes

9. **Studies conducted on flossing with a floss holder found:**
   a. People preferred the floss holder to string floss
   b. The floss holder was less effective than string floss
   c. The floss holder caused flossing cuts and clefts
   d. The floss holder was hard to use

10. **The rubber tip stimulator:**
    a. Has been shown to reduce plaque and gingivitis
    b. Has been shown to reduce periodontal pockets
    c. Has rarely been clinically evaluated
    d. None of the above

11. **The review by Husseini et al. on the oral irrigator found:**
    a. Periodontal maintenance patients who used the water flosser daily for 3 months did not increase the risk of developing a bacteremia
    b. A beneficial effect on gingivitis, bleeding, and pocket depth reductions
    c. A bacteremia rate similar to those of other home care products
    d. All of the above

12. **Since the systematic review by Husseini et al., how many additional studies have been conducted on the water flosser?**
    a. 0
    b. 6
    c. 15
    d. 21

13. **The water flosser has been shown to be more effective at improving oral health than:**
    a. String floss
    b. A device powered by water
    c. Interdental brushes
    d. All of the above

14. **Which statement is true about the water flosser?**
    a. It produces sheer hydraulic forces to remove plaque
    b. It can remove up to 99.9% of plaque from a treated area
    c. Both A & B
    d. None of the above

15. **When it comes to safety and home care products:**
    a. Any product can be misused
    b. Benefits generally outweigh risks
    c. Instruction is essential
    d. All of the above

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**Nationally Approved PACE Program Provider for FAGD/MAGD credit.**
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**6/1/2022 to 5/31/2026.**
**Provider ID# 210474**

**This free self-study is designed for all dental professionals – no prior skills are needed.**


PN 20025099-STD
FN 20025099STD-F AE

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