



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

This paper reviews the relative efficacy of different interdental cleaning methods in preventing and treating gingivitis and periodontitis based upon the latest evidence from randomized controlled studies, systematic reviews and meta-analyses.



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# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## ABSTRACT

Gingivitis affects up to 90% of the world's population; periodontitis up to 50% of adults worldwide. Appropriate primary and secondary prevention both depend on daily mechanical plaque removal and are the recommended and most affordable ways to reduce the incidence of these diseases.

This review of interdental cleaning approaches is based upon the latest evidence base. The relative efficacy of different interdental cleaning methods is provided in accordance with the latest randomized controlled studies (RCTs), and when available, systematic reviews and meta-analyses.

Our review indicates that accumulated data unequivocally demonstrates that interdental cleaning plus tooth brushing is better than tooth brushing alone, for both the prevention and treatment of gum disease. Moreover, interdental cleaning with brushes and with rubber interdental cleaners is better than interdental cleaning with floss – both in terms of outcomes and patient preference.

Compliance with a daily oral hygiene routine at home is one of the greatest issues in dental care. Accordingly, providing patients with care regimens that are easy to use and facilitate compliance are likely to be the most effective and simplest ways to maximize dental hygiene and reduce the incidence of gum disease.

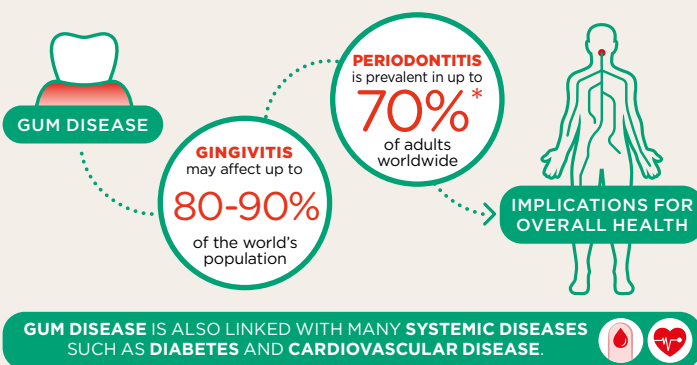
## PLAQUE AND GUM DISEASE

Plaque is a sticky biofilm containing bacteria that can accumulate on and between the teeth and below the gumline. With prolonged contact, the gums

become irritated by the harmful bacteria, leading to redness, bleeding on brushing, swelling and pain, as well as bad breath (Cheung 2010; Pihlstrom 2005). The early and reversible form of gum disease is called **gingivitis**, which may affect up to 90% of the world's population (Albandar 2002). If bacteria spreads below the gum line, **periodontitis** can occur (Pihlstrom 2005) – a severe inflammatory disease where the inflamed gums pull away from the teeth to form infected pockets, and the body's immune system is triggered to fight the infection. Over time, the onslaught by bacterial toxins and immune factors can destroy the integrity of the bones, gums and tissue that support the teeth, leading to tooth and bone loss (Pihlstrom 2005). Periodontitis is thought to affect around 50% of adults worldwide, and is especially prevalent in older populations (70–90% of people over the age of 60 years in Europe) (Borgnakke 2013).

Gum disease has a negative impact on a patient's oral health-related quality of life, especially aspects related to the patient's

GUM DISEASE IS VERY COMMON AND CAN ADVERSELY AFFECT ORAL HEALTH-RELATED QUALITY OF LIFE AND FUNCTIONING.



\* Eke PI, Dye BA, Wei L, Thornton-Evans GO, Geneco RJ, "Prevalence of periodontitis in adults in the United States: 2009 and 2010, J Dent Res. Oct 2012

Figure 1: Prevalence of Gingivitis and Periodontitis



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appearance, and affects their ability to eat and talk properly if periodontitis results in tooth loss (Reynolds 2018; Ferreira 2017). Gingivitis has been associated with pain and discomfort, which causes difficulties when cleaning the teeth (Ferreira 2017). As the disease becomes more severe, so does the impact on quality of life (Ferreira 2017). Gum disease is also linked with many other systemic disorders, including diabetes, cardiovascular disease and pre-term birth (Monsarrat 2016).

Gum disease is very common and can adversely affect oral health-related quality of life and functioning. Gingivitis may affect up to 90% of the world's population, while periodontitis is prevalent in up to 50% of adults worldwide. Gum disease is also linked with many systemic diseases such as diabetes and cardiovascular disease.

## GOOD INTERDENTAL CARE IS ESSENTIAL FOR PLAQUE CONTROL

Good dental hygiene is important for gingival health, preventing gum disease and its associated adverse effects – but relies on patients effectively cleaning their teeth and gums every day (Jepsen 2017). Manual disruption of plaque biofilm development above the gum line remains one of the best forms of treatment (Chandki 2011).

There are several options available to patients that can be used daily at home to prevent the build-up of plaque (Johnson 2015). Toothbrushing with a manual or powered toothbrush remains the most common method used worldwide (Johnson 2015). This despite an elegant 1981 demonstration by Lindhe that traditional dental care does not prevent the progression of caries and periodontitis in adults (Lindhe 1981). In fact, although toothbrushing removes biofilm from the buccal, oral, and occlusal surfaces, it does not reach efficiently into the interdental areas (Poklepovic 2013; Halappa 2015). Moreover, brushing for less than 2 minutes results in removal of only 4% of accumulated plaque (Sheikh-Al-Eslamian 2014). This is why twice-daily inter-dental cleaning is now universally recognized as the only means to prevent gum disease and or to

halt its progression (Graziani 2019). Accordingly, various interdental cleaning devices have been developed and can be used in combination with toothbrushing.

- **Flossing** is commonly recommended, using string floss or floss picks, and can be effective at removing interdental plaque if used properly (Asadoorian 2006). However, its efficacy is reduced if an incorrect technique is used (Drisko 2013; Azcarate-Velázquez 2017). Although the correct technique can be taught, patient compliance with daily flossing is low because it requires a degree of dexterity and motivation that some patients find hard to achieve (Poklepovic 2013). A wide range of low compliance rates, between 2% and 49%, has been reported for the daily use of floss (Wilder 2016).
- **Interdental brushes (IDBs)** with cylindrical or conical bristles of varying sizes can be used to brush between the teeth, space permitting (Johnson 2015). IDBs are thought to be more effective at plaque removal than floss because the bristles are better able to fill the space between the teeth and remove plaque (Johnson 2015). Because IDBs are regarded by patients as being easier to use than floss, they are much more willing to use them (Christou 1998; Imai 2010). However, questions remain regarding their efficacy at reducing gingival inflammation and whether they can be used in orally-healthy people to prevent gum disease (Johnson 2015).
- **Interdental picks** are another option used to remove plaque. Newer picks have a rubber tip with rubber bristles, designed to stimulate gingival blood flow and remove interdental plaque (Johnson 2015). These **rubber interdental picks (RIPs)** may be more acceptable to patients than IDBs because they are easier to use and cause fewer gum abrasions (Hennequin-Hoenderdos 2018).
- **Oral irrigators** or **air flossers**, which use water or air under pressure, may also remove plaque from teeth and periodontal pockets (Goyal 2012). However, such devices are generally expensive compared to other interdental methods, and cannot easily be used on the go or when traveling.



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## WHICH INTERDENTAL CLEANER IS THE MOST EFFECTIVE?

Despite recommendations to use an interdental cleaner alongside daily toothbrushing, it has been debated whether one type of interdental cleaner is superior to another (Johnson 2015). Therefore, evidence from randomized controlled trials and from systematic reviews and meta-analyses was reviewed for commonly-available interdental cleaning methods – namely floss, interdental brushes (IDBs), and rubber interdental picks (RIPs) (water- and air-driven options were not considered because of their higher cost and more limited availability). A simple search strategy was devised in PubMed, using the search term ‘interdental’ and the relevant type of trial, in humans. Papers were selected according to whether they compared the efficacy of the techniques at controlling plaque for prevention of gum disease in orally-healthy individuals or treatment of gum disease in patients with gingivitis or periodontitis.

### The studies identified included:

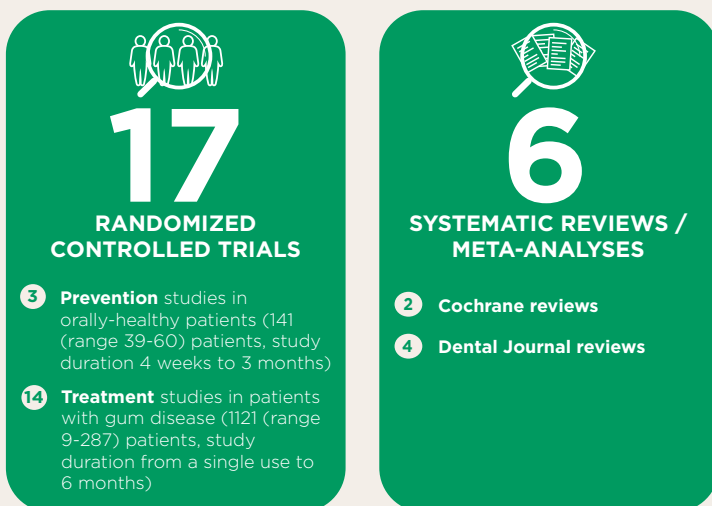


Figure 2: Identified Publications

Details and key results from all studies identified are included in the Appendix, including a brief explanation of the trial designs and efficacy measures that are used in oral hygiene studies.

### It is important to note that:

- 
 Use of a toothbrush alone or in combination with any interdental product reduces plaque and inflammation compared with baseline (i.e. before any kind of cleaning takes place)
- 
 All interdental devices support the management of gum disease, but to a varying extent (Salzer 2015).
- 
 Some interdental products are more effective than others, and certainly more effective than toothbrushing alone (Figure 5 page 9 and Appendix).

Figure 3: Interdental cleaning devices and gum disease

### PREVENTION OF PERIODONTAL DISEASE

- Interdental cleaning compared with toothbrushing alone.** In orally-healthy patients, both IDBs and RIPs were more effective than toothbrushing alone, with significantly greater reductions in **interdental plaque** with IDBs and RIPs (Graziani 2018), **bleeding** from 1 week with IDBs (Bourgeois 2016), and **gingival inflammation** with IDBs (Kotsakis 2018).
- Interdental brushes compared with floss.** IDBs were more effective than floss in orally-healthy patients, resulting in a significantly greater reduction in **interdental plaque** from 1 week (Graziani 2018) and a reduction in **gingival inflammation** (Kotsakis 2018).
- Rubber interdental cleaners compared with floss.** New evidence shows that RIPs were also more effective than floss in orally-healthy patients, leading to significantly lower levels of **interdental plaque** and **inflammation** (Graziani 2018).



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- **Interdental brushes compared with rubber interdental cleaners.**

The efficacy of IDBs and RIPs was comparable in orally-healthy patients; both significantly reduced **interdental plaque** after a single use and **bleeding** after 4 weeks compared with baseline, with no significant differences between the cleaners (Abouassi 2014). The benefits of IDBs and RIPs are evident from 1-2 weeks (Graziani 2018; Bourgeois 2016; Abouassi 2014).

- Gum disease is often seen in older people, but **prevention is possible in younger people**; interdental cleaning significantly reduces plaque and gingival inflammation in orally-healthy subjects younger than 30 years of age (Graziani 2018; Bourgeois 2016).

## TREATMENT OF PERIODONTAL DISEASE

- **Interdental brushes compared with toothbrushing alone.**

IDBs were more effective than toothbrushing alone in patients who already had gum disease, resulting in significantly greater reductions in **interdental plaque** (Jared 2005; Slot 2008), **bleeding** at 4 weeks (Jared 2005), and **gingival inflammation** (Kotsakis 2018; Poklepovic 2013).

- **Interdental brushes compared with floss.**

IDBs were also more effective than floss in patients with gum disease, leading to a significantly greater reduction in **interdental plaque** (Tu 2008; Jackson 2006; Rosing 2006; Jared 2005; Christou 1998; Imai 2012; Slot 2008), **gingival inflammation** (Jackson 2006; Jared 2005; Kotsakis 2018; Poklepovic 2013), **pocket depth** (Tu 2008; Jackson 2006; Christou 1998; Slot 2008), **bleeding** (Tu 2008; Noorlin 2007; Jackson 2006; Jared 2005; Imai 2012; Slot 2008), and **buccal gingivitis** (Yost 2006). **Whatever their shape**, IDBs are more effective at removing plaque (Rosing 2006) and reducing gingivitis (Yost 2006) than floss. The greater reduction in pocket depth and bleeding on probing reported with the use of IDBs compared with floss was mostly due to the greater efficiency of interdental brushing in removing dental plaque, rather than compression of interdental papillae (Tu 2008). IDBs are

preferable to floss in cleaning interdental areas where the papilla is missing (Bergenholtz 1984).

- **Interdental brushes compared with rubber interdental cleaners.**

The efficacy of IDBs and RIPs was initially comparable when used to treat gum disease, but some differences emerged over time. While there was a significant decrease in **interdental plaque** and **bleeding** with both cleaners compared to baseline, there was a significantly greater decrease in **bleeding, gingival inflammation** and **gingival abrasions** at 4 weeks with RIPs compared with IDBs (Hennequin-Hoenderdos 2018). The benefits of IDBs and RIPs may be more consistent after a few weeks (Jared 2005; Hennequin-Hoenderdos 2018).

- A meta-review of systematic reviews indicated that **IDBs** reduce both plaque and gingivitis and **are the most effective method for plaque removal** (Salzer 2015). However, only weak evidence exists that floss and oral irrigators reduce gingivitis, with no concomitant evidence for an effect on plaque (Salzer 2015). Most studies failed to demonstrate that floss is effective in plaque removal for patients suffering from periodontitis. (Salzer 2015; Sambunjak 2011). However, people who brush and floss regularly have less gum inflammation and bleeding compared to toothbrushing alone (Sambunjak 2011).
- After analysis of the available studies and the outcomes assessed within them, **IDBs have been ranked the highest at being the 'best' interdental device for reducing gum inflammation**, while the probability for toothpicks (using hard materials) and floss being the 'best' aids was ranked near to zero (Kotsakis 2018).
- Interdental cleaning, **especially with IDBs**, is advantageous in all patient populations, including in patients with chronic periodontitis; interdental cleaning can improve clinical periodontal outcomes and reduce clinical signs of disease and inflammation over 3 months, with minimal professional intervention (Jackson 2006).



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## PATIENT PREFERENCE AFFECTS COMPLIANCE WITH TREATMENT

Management of gum disease relies mainly on a patient’s ability to clean their own teeth effectively (Jepsen 2017). Yet patients often do not follow recommendations from healthcare providers (Wilder 2016; Poklepovic 2013). Toothbrushing alone is usually insufficient (Sheikh-Al-Eslamian 2014; van der Weijden 2005), and flossing may be ineffective unless the right technique is used (Drisko 2013; Azcarate-Velázquez 2017). However, flossing can be difficult to perform correctly (Poklepovic 2013), leading to reduced motivation in real life (compared with the controlled environment of a trial) and a lack of compliance with daily interdental cleaning (Asadoorian 2006).

combined with supportive education and homecare regimens.

To date, several studies have evaluated the patient acceptance of interdental devices. These have shown that **patients prefer IDBs compared with floss**, based on the fact they are easier to use and likely to be used more efficiently than floss (Christou 1998; Noorlin 2007). For example, in a study of people with intact but bleeding interdental gums, 93% of patients ‘agreed’ or ‘strongly’ agreed to use IDBs daily, compared with 67% of patients for floss (Imai 2010). In patients with mild-to-moderate periodontitis, 90% thought IDBs were ‘easy’ or ‘very easy’ to use compared with 60% when using floss (Noorlin 2007). Patients with mild-to-moderate periodontitis also preferred IDBs to floss in another study, rating them as being easier to use (only 12% of patients experienced a problem when using the IDB compared with 58% of patients when using floss) and more effective at cleaning (Christou 1998).

### The prevention and control of gum disease is a lifelong commitment

(Jepsen 2017).



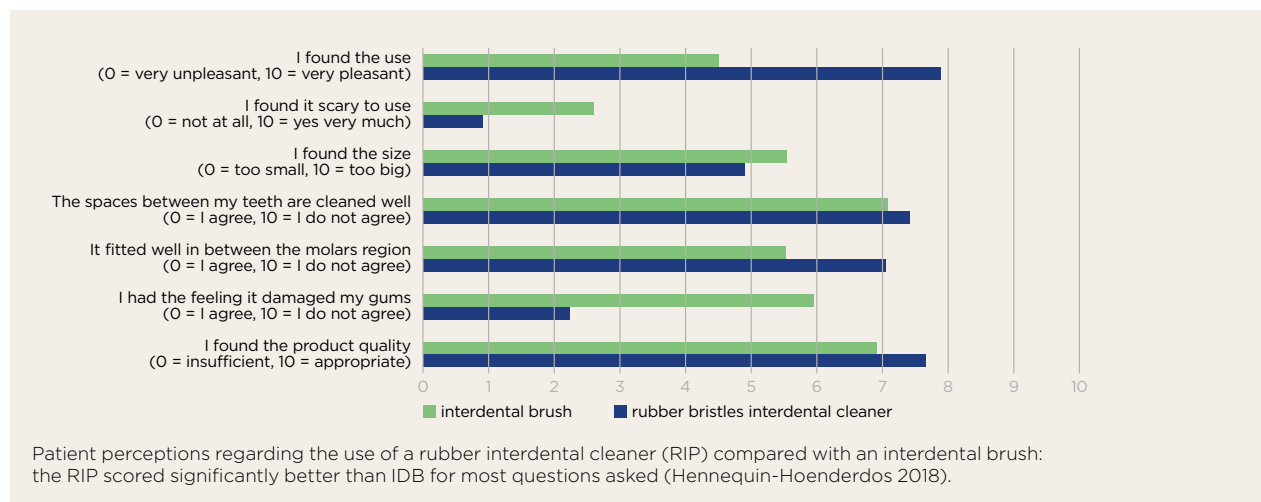
### Less-demanding methods of interdental cleaning may increase motivation and thus improve patient outcomes

(Needleman 2005; Wilder 2016).

Thus, less-demanding methods of interdental cleaning are necessary (Asadoorian 2006), which may increase motivation and change patient behavior – and thus improve patient outcomes (Needleman 2005; Wilder 2016). Utilizing technology and techniques that help to improve a patient’s experience should contribute to improving adherence to an oral hygiene routine, especially when

### Patient compliance with an oral hygiene routine may be further improved by using a RIP rather than an IDB.

In orally-healthy patients, patient acceptance and willingness to buy the product was greater with RIPs than IDBs because they caused less pain during usage and were significantly more comfortable to use (Abouassi 2014). A recent study in patients with gum disease has also confirmed the significantly greater patient acceptance with RIPs compared with IDBs (Figure 2) (Hennequin-Hoenderdos 2018).



**Table 1. Patient perceptions regarding RIP**



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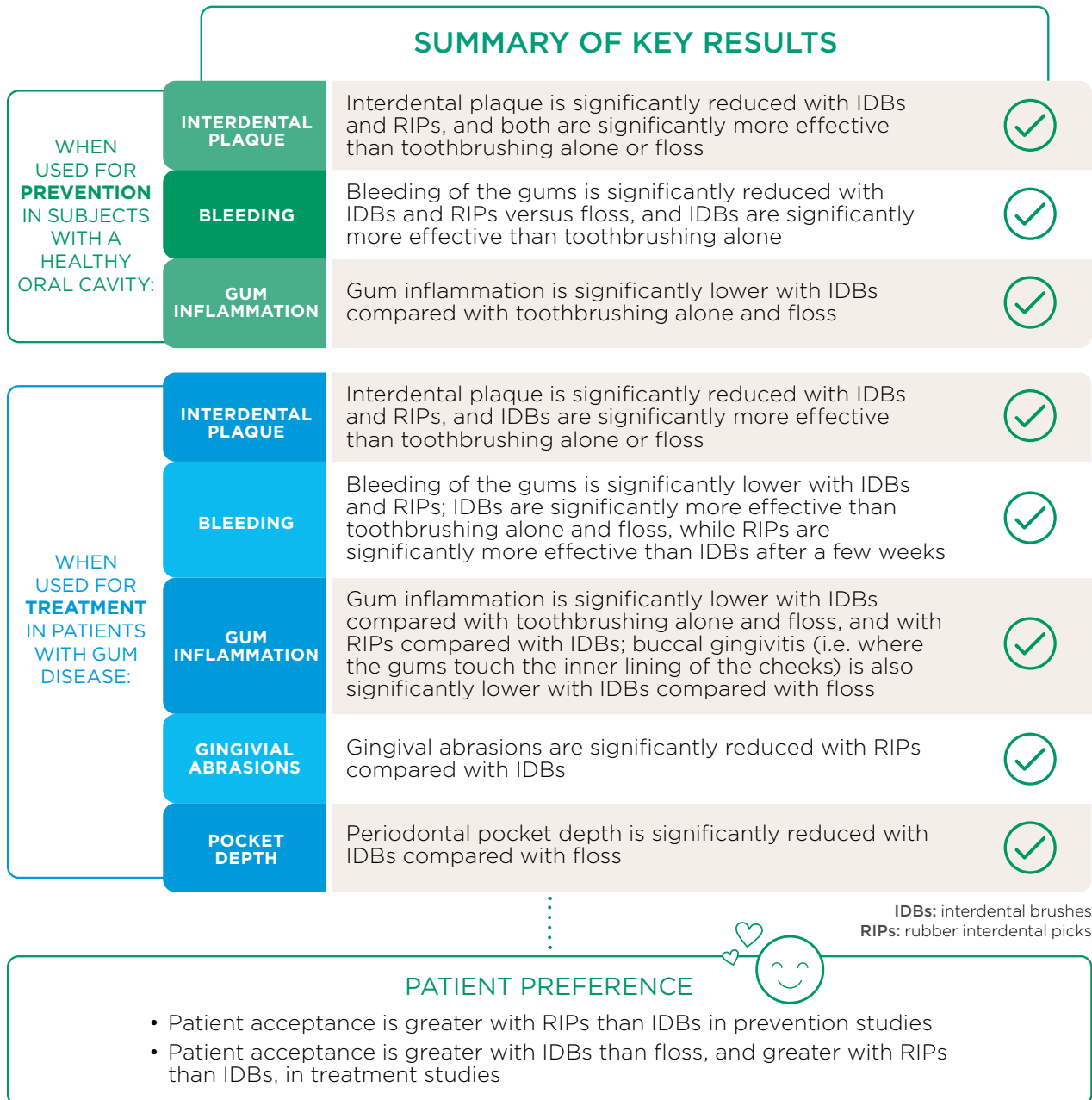


Figure 4: Summary of key results

**Results clearly demonstrate that IDBs and RIPs are the most effective interdental cleaners in the prevention and treatment of gum disease.**

Both are better than toothbrushing alone, and are more effective than floss at removing harmful plaque. (Graziani, 2019)

**Both IDBs and RIPs are well accepted by patients, with the latest RIP designs associated with greater preference compared with IDBs.**

It should be noted that newer devices such as RIPs were not included in earlier studies. Additional randomized controlled trials comparing the use of IDBs and RIPs in combination with toothbrushing versus toothbrushing alone or in combination with floss would be beneficial to confirm the benefits of each at preventing and treating gum disease.





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## SUMMARY

Accumulating data, including both very recent publications and papers of more than 20 years old, unequivocally demonstrate that:

- Interdental cleaning plus toothbrushing is better than toothbrushing alone for both the prevention and treatment of gum disease.
- Interdental cleaning with brushes and with rubber interdental cleaners is better than interdental cleaning with floss.
- Current evidence suggests that patients prefer IDBs to floss. Patients also prefer to use RIPs than IDBs for interdental cleaning because they are easier and more comfortable to use and cause less pain.
- Compliance with a daily oral hygiene routine at home is one of the greatest issues in dental care. Accordingly, providing patients with care regimens that are easy to use and facilitate compliance are likely to be the most effective and simplest manner to maximize dental hygiene.

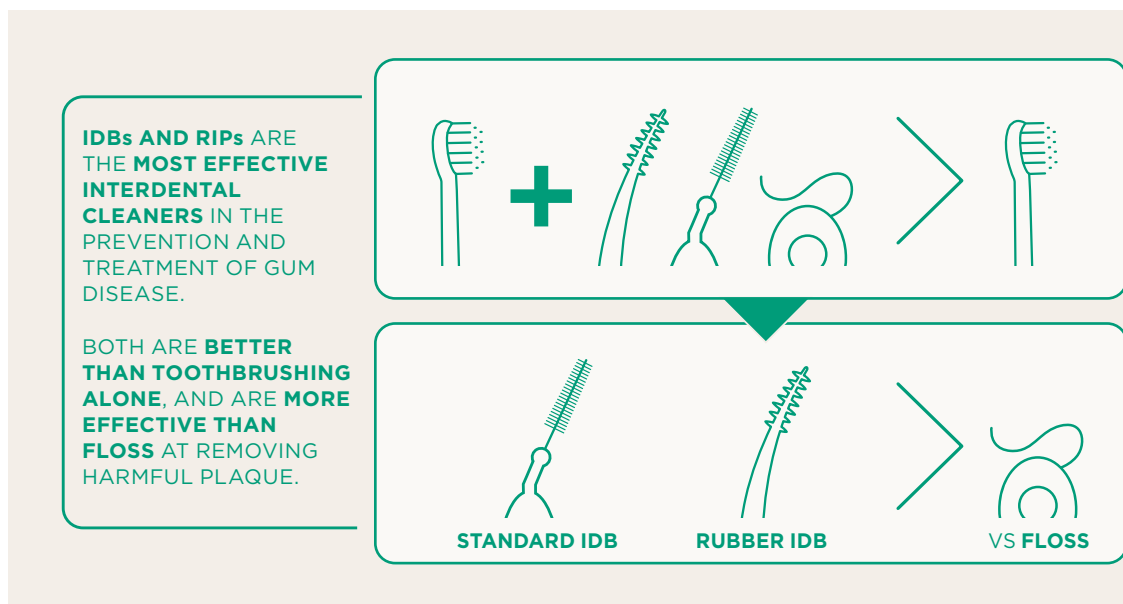


Figure 5: Interdental Devices in perspective



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## APPENDIX I

### A BRIEF GUIDE TO ORAL HYGIENE RANDOMIZED CONTROLLED STUDIES (RCTS)

#### Oral hygiene RCT studies can be grouped into two types

- Studies of oral hygiene status in relation to dental caries and periodontal disease – usually contain large numbers of patients
- Studies of the effectiveness of the use of various techniques, procedures and devices for cleaning the teeth – usually contain smaller numbers of patients; the key studies in this document fall under this type

#### Study Design for Oral Hygiene

In oral hygiene studies it is not possible to use the normally-desirable “double-blind” design, as patients clearly know which device they are using. However, a single-blind design is possible, where the examiner is blinded to the treatment used. This is the design used in the best oral hygiene RCTs.

Patients can be randomized into separate treatment groups, including a control group, with the results in one group compared against the other. More frequently, a “**half-“ or “split-mouth” design** is used, where patients act as their own controls (thereby reducing interindividual variability) and use a different product for each side of the mouth.

#### Study Design for Prevention Studies

In “prevention” studies in orally-healthy people, “**experimental gingivitis**” is induced by asking patients to refrain from oral hygiene for a set period of time (from hours to a week or two) before they begin treatment (baseline).

#### Outcome Measures

In all studies, outcomes are measured at baseline and at the end of the study and compared to see whether there are any significant differences – i.e. whether differences are due to an actual treatment effect rather than to chance. This is represented by the p-value. Usually, if the difference between the treatments results in a p-value of less than 0.05, it is regarded as significant (e.g.  $p < 0.01$  is significant, but  $p = 0.06$  is not significant).



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## APPENDIX II

### A BRIEF OVERVIEW OF ORAL HYGIENE OUTCOME MEASURES

Outcome	How is it measured?	Comments
<b>Plaque</b> Interdental plaque Buildup of plaque	<b>Index measures</b> (proportion of tooth surface with plaque) <ul style="list-style-type: none"> <li>• Silness-Löe Index (1964): score 0-3, with 0=no plaque and 3=abundant plaque; four scores for different areas of the teeth (buccal, lingual, mesial, distal) are averaged</li> <li>• Plaque Control Record (1972): a simple method of recording plaque in different areas of the teeth (buccal, lingual, mesial, distal), using a solution painted onto the teeth that stains the plaque</li> <li>• Quigley-Hein Plaque Index: score 0-5, where 0=no plaque to 5=plaque covering two-thirds or more of the crown of the tooth</li> <li>• FMPS (Full Mouth Plaque Score): Presence/absence of plaque scores measured dichotomously on six sites per tooth and then calculated as a percentage of the total tooth surface</li> <li>• Interdental full-mouth plaque score (Int. FMPS)</li> </ul> <b>NEW Image analysis/planimetric techniques</b> <ul style="list-style-type: none"> <li>• Quantitative light-fluorescence (QLF) images from buccal surfaces</li> </ul>	<ul style="list-style-type: none"> <li>• There are various methods of quantification of dental plaque in the research environment, ranging from simple to very complex</li> <li>• Index measures provide composite visual measurements</li> <li>• Image analysis is more “scientifically rigorous” because images are recorded and can subsequently be validated by another party</li> </ul>
<b>Bleeding</b> Bleeding of the gums FMBS (Full Mouth Bleeding score)	<b>Bleeding on probing (BOP)</b> <ul style="list-style-type: none"> <li>• Bleeding that is induced by gentle manipulation of the tissue at the depth of the gingival sulcus, or interface between the gingiva and a tooth</li> </ul> <b>Bleeding on marginal probing (BOMP) index</b> <ul style="list-style-type: none"> <li>• The gingival margin is probed at an angle and the absence or presence of bleeding is scored within 30 seconds of probing on a scale 0-2, where 0=no bleeding to 2=excessive bleeding</li> </ul> <b>FMBS (Full Mouth Bleeding score)</b>	<ul style="list-style-type: none"> <li>• BOP is a sign of inflammation</li> </ul>
<b>Gingival inflammation</b> Gum inflammation Gingivitis Buccal gingivitis	Index measures <ul style="list-style-type: none"> <li>• <b>Gingival Index:</b> each tooth is divided into four gingival units (mesial, distal, buccal, and lingual) and given a score from 0-3, where 0=normal gingiva to 3=severe inflammation. The four scores are then averaged to give each tooth a single score</li> </ul> <b>NEW Digital image analysis:</b> <ul style="list-style-type: none"> <li>• Provides good reliability for both intra- and inter-examiner measurements (Smith 2008)</li> <li>• Measured in millimeters using a periodontal probe; combined with radiographic images</li> </ul>	<ul style="list-style-type: none"> <li>• Index measures provide composite visual monuments</li> <li>• Digital image analysis is more precise but more cumbersome and newer</li> <li>• “Gingival recession” is another measure in this category.</li> </ul>
<b>Pocket depth</b> Periodontal pocket depth Maximal pocket depth Probing Pocket depth	<b>NEW Optical coherence tomography (OCT)</b> <ul style="list-style-type: none"> <li>• OCT images of periodontal pockets is a new method in development</li> </ul>	<ul style="list-style-type: none"> <li>• Pocket depth is a common means of measuring periodontal inflammation</li> <li>• Periodontal probing is frequently used but reliability and reproducibility are inconsistent; X ray imaging may underestimate bone loss, which can make early detection difficult – hence the development of new measures such as OCT</li> </ul>
<b>Gingival abrasion</b>	<b>Gingival abrasion (GA) scores</b> <ul style="list-style-type: none"> <li>• Scored by size with probe: abrasions are stained (e.g. blue) and measured using a periodontal probe. They are then scored and small, medium and large in millimeters</li> <li>• Scored by size with photographs, using a predefined method</li> </ul>	<ul style="list-style-type: none"> <li>• Gingival abrasion can be caused by toothbrushing</li> </ul>
<b>Patient acceptance</b>	Typically measured using patient surveys	



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## APPENDIX III

### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

RANDOMIZED CONTROLLED TRIALS - Orally-healthy individuals (prevention)						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Graziani 2018</b>	Periodontally-healthy young adults (60)	4 wks	MTB alone MTB + floss MTB + IDB MTB + RIC	FMPS (plaque) FMBS (inflammation) AngBI (indicator of gingivitis)	<ul style="list-style-type: none"> <li>Wk 1: significant decrease in plaque in all groups except floss</li> <li>Wk 4: significant decrease in plaque and inflammation in all groups</li> <li>Significantly lower interdental plaque with MTB + IDB or RIC vs. MTB alone</li> <li>Significantly less interdental inflammation with RIC vs. floss</li> </ul>	<ul style="list-style-type: none"> <li>In periodontally-healthy young subjects, interdental cleaning devices can significantly reduce plaque and gingival inflammation</li> <li>MTB + IDB or RIC reduced interdental plaque more than MTB alone</li> </ul>
<b>Bourgeois 2016</b>	Periodontally-healthy young adults (42)	3 mo	MTB + IDB MTB alone	BOIB (indicator of gingivitis) Bleeding response to pressure in interdental area	<ul style="list-style-type: none"> <li>Significant decrease in bleeding with MTB + IDB at 1 wk through to 3 mo compared with baseline (no significant difference with MTB alone)</li> <li>Preventive fraction for bleeding frequency with MTB + IDB 46% at 1 wk, 72% at 3 mo</li> <li>Greater bleeding reduction in anterior (80%) vs. posterior sites (69%)</li> <li>Presence of bleeding with MTB alone, OR 4.3</li> <li>Poorer results with IDB with high baseline bleeding vs. low baseline bleeding (OR 2.3)</li> <li>Higher odds of bleeding with IDB in posterior vs. anterior sites (OR 2.2)</li> <li>Larger diameter IDB associated with smaller amount of bleeding</li> </ul>	<ul style="list-style-type: none"> <li>Daily use of calibrated IDBs has a positive impact in reducing interproximal bleeding of periodontally healthy young participants from 1 wk</li> </ul>
<b>Abouassi 2014</b>	Adults (39)	4 wks	RIC IDB	Gingival bleeding Plaque removal Patient experience	<ul style="list-style-type: none"> <li>Significant decrease in plaque after a single usage of RIC and IDB</li> <li>Significant reduction in bleeding after 4 wks, with no significant differences between groups</li> <li>Significantly greater patient acceptance with RIC in overall assessment and subitems for less pain during usage, comfort of brushing, willingness to buy product</li> </ul>	<ul style="list-style-type: none"> <li>RIC similarly effective to IDB</li> <li>RIC significantly more comfortable than metal-core IDB</li> <li>RIC can be used as alternative interdental cleaning product, may be more accepted by patients</li> </ul>



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## APPENDIX III

### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

RANDOMIZED CONTROLLED TRIALS - Patients with gingivitis or periodontitis						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Hennequin-Hoenderdos 2018</b>	Systemically-healthy young adults with experimental gingivitis (42)	4 wks	MTB + RIC MTB + IDB	BOMP (indicator of gingivitis) PI (plaque) GAs (gingival abrasions)	<ul style="list-style-type: none"> <li>Significant reduction in bleeding and plaque with RIC and IDB vs. baseline – but no significant differences between groups, apart from significantly less bleeding with RIC vs. IDB at 4 wks</li> <li>Significantly fewer gingival abrasions with RIC</li> <li>RIC considered significantly more pleasurable to use</li> </ul>	<ul style="list-style-type: none"> <li>MTB + RIC more effective than MTB + IDB in reducing gingival inflammation after 4 wks</li> <li>RIC caused less gingival abrasion and was appreciated more by participants than IDB</li> </ul>
<b>Larsen 2017</b>	Periodontal maintenance patients (51)	3 mo	Conical IDB Cylindrical IDB	Plaque scores Bleeding upon pocket probing scores Probing pocket depth	<ul style="list-style-type: none"> <li>Overall, no difference between conical and cylindrical IDBs</li> <li>Significantly higher plaque and bleeding scores at lingual approximal sites with conical IDB (increase in plaque and bleeding scores compared with baseline)</li> <li>No difference in probing pocket depth between IDBs</li> </ul>	<ul style="list-style-type: none"> <li>Conical IDBs less effective than cylindrical IDBs regarding lingual approximal plaque removal</li> <li>In patients receiving supportive periodontal therapy, cylindrical IDB should be first choice to obtain and maintain gingival</li> </ul>
<b>Mwatha 2017</b>	Young and old adults with mild to moderate gingivitis (287)	4 wks	MTB alone MTB + string floss MTB + two different types air floss (4 groups)	MGI (gingivitis) RMNPI (plaque) GBI (bleeding)	<ul style="list-style-type: none"> <li>Significantly larger reductions in MGI in all three floss groups compared to MTB alone at day 14 (primary endpoint)</li> <li>Benefits persisted for up to 4 wks</li> </ul>	<ul style="list-style-type: none"> <li>Addition of interproximal cleaning to MTB significantly reduced gingivitis and plaque vs. MTB alone</li> <li>String and air floss provided a similar reduction in gingivitis and plaque</li> </ul>
<b>Stone 2015</b>	Adults with gingival manifestations (79)	20 wks	Sonic TB + IDB MTB alone	OHIP (impact on life) Pain PI (plaque) Mucosal disease score Cost-effectiveness	<p>With Sonic TB + IDB vs. MTB alone:</p> <ul style="list-style-type: none"> <li>Significant improvements in OHIP</li> <li>Improvements in functional limitation, psychological discomfort and physical disability at 4 and 20 wks, and psychological disability at 20 wks</li> <li>Reduction in plaque</li> <li>Improvements in mucosal disease indices at 4 and 20 wks</li> </ul>	<ul style="list-style-type: none"> <li>A structured plaque control intervention effective in improving oral health-related quality of life and clinically observed gingival lesions</li> </ul>



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## APPENDIX III

### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

RANDOMIZED CONTROLLED TRIALS - Patients with gingivitis or periodontitis						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Tu 2008</b> (re-analysis of Jackson 2006)	Young and old adults with chronic periodontitis (77)	12 wks	MTB + floss MTB + IDB	PPD (pocket depth) PI (plaque) BOP (bleeding)	<ul style="list-style-type: none"> <li>Significantly greater reduction in PPD and percentage sites with bleeding on probing with MTB + IDB vs. MTB + floss</li> <li>Most changes occurred during first 6 wks</li> <li>Greater reduction in PI with MTB + IDB vs. MTB + floss, leading to greater pocket depth reduction and greater improvement in bleeding on probing</li> </ul>	<ul style="list-style-type: none"> <li>Greater reduction in pocket depth and bleeding on probing with MTB + IDB vs. MTB + floss mostly due to greater efficiency of interdental brushing in removing dental plaque (rather than compression of interdental papillae)</li> <li>Improved oral hygiene performance can reduce gingival inflammation and yield greater pocket reduction and less bleeding on probing</li> </ul>
<b>Noorlin 2007</b>	Untreated adults with mild-moderate periodontitis (prior to debridement) (10)	1 mo	MTB + IDB MTB + floss	Probing depth BOP (bleeding) Recession (gum)	<ul style="list-style-type: none"> <li>Significant differences in supragingival and subgingival plaque scores with MTB + IDB an MTB + floss over time, but no significant differences between groups</li> <li>Significant reduction in BOP, probing depth and recession over time for IDB sites, but not floss sites</li> <li>Patients preferred IDB because of its simpler method of use</li> </ul>	<ul style="list-style-type: none"> <li>Use of MTB + IDB or floss resulted in similar beneficial effects on subgingival plaque and proximal gingival health</li> <li>IDB is more likely to be used efficiently than floss</li> </ul>
<b>Schiffner 2007</b>	Older patients (106)	6 mo	MTB + interdental treatment Oral antibacterial mouth rinse Manual + antibacterial combination No specific regimen (4 groups)	Gingivitis Plaque	<ul style="list-style-type: none"> <li>Significantly lower plaque and gingivitis scores at 6 mo vs. baseline in all groups</li> <li>Significant reductions in gingivitis between control group and all other groups, but not between intervention groups</li> <li>Only groups with improved manual oral hygiene showed significant improvements in plaque scores vs. control</li> </ul>	<ul style="list-style-type: none"> <li>Greater plaque reduction with intensive manual oral hygiene than combination of antibacterial rinse and usual oral hygiene procedures</li> <li>Gingivitis reduced by both intensive manual oral hygiene and antibacterial rinse</li> <li>Combining intensive manual oral hygiene with antibacterial rinse did not result in further gingivitis reduction</li> </ul>





# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

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### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

RANDOMIZED CONTROLLED TRIALS - Patients with gingivitis or periodontitis						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Jackson 2006</b>	Young and old adults with chronic periodontitis (prior to debridement) (77)	12 wks	MTB + floss MTB + IDB	PI (plaque) RICL (papillae level) EIBI (gingival inflammation) Probing depths BOP	<ul style="list-style-type: none"> <li>Significant reductions from baseline for all indices in both groups</li> <li>At 6 wks, IDB group improved significantly more than floss group in every parameter</li> <li>By 12 wks, changes in plaque, papillae level, and probing depths significantly greater in IDB vs. floss group</li> </ul>	<ul style="list-style-type: none"> <li>Interdental cleaning, especially with IDB, enabled patients with chronic periodontitis to improve clinical periodontal outcomes and reduce clinical signs of disease and inflammation over 12 wks</li> <li>Significant improvements achieved with minimal professional intervention before thorough root surface debridement</li> <li>IDB significantly outperformed floss at 6 wks (all indices) and 12 wks (interdental plaque, papillae height, probing depth)</li> </ul>
<b>Rosing 2006</b>	Adults with periodontitis (50)	Single use	Floss Cylindrical IDB Conical IDB	PI (plaque)	<ul style="list-style-type: none"> <li>Significant decrease in plaque with all three instruments vs. baseline</li> <li>Significantly greater decrease with both IDB vs. floss</li> </ul>	<ul style="list-style-type: none"> <li>In individuals in periodontal maintenance care, IDB - regardless of their shape (conical, cylindrical) - are more efficacious in interdental supragingival plaque removal than floss</li> </ul>
<b>Yost 2006</b>	Adults with gingivitis (120)	6 wks	String floss Flossers IDB RIC	EIBI (bleeding) Plaque Gingivitis	<ul style="list-style-type: none"> <li>With all four products, significant reduction in interdental plaque and reduction in interdental gingivitis scores both lingually and buccally at 6 wks vs. baseline</li> <li>No statistical differences between products on lingual interdental sites</li> <li>Significantly greater reduction in gingival index score buccally with IDB vs. other three products</li> <li>No differences among products regarding bleeding</li> </ul>	<ul style="list-style-type: none"> <li>Dental floss, the recognized "gold standard" for gingivitis reduction, was matched in performance by flossers and RIC, but surpassed by the IDB</li> <li>All products performed comparably for plaque reduction and removal, and for reduction in inflammation</li> <li>On the buccal surfaces, the greatest reduction in gingivitis was achieved with the IDB</li> </ul>



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## APPENDIX III

### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

RANDOMIZED CONTROLLED TRIALS - Patients with gingivitis or periodontitis						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Jared 2005</b>	Adults with gingivitis (152)	4 wks	Antiseptic-releasing IDB Two other IDB products Floss MTB alone (5 groups)	Plaque Gingivitis Interproximal gingival bleeding	<ul style="list-style-type: none"> <li>Significantly lower plaque levels with all three IDB vs. MTB alone at 2 and 4 wks</li> <li>Significant improvement in interproximal gingival bleeding with antiseptic-releasing IDB at 2 wks; significantly better outcomes with all three IDB at 4 wks vs. MTB alone</li> <li>Significantly greater reduction in interproximal bleeding upon probing with all three IDB vs. floss and MTB alone at 2 and 4 wks</li> <li>No clinically superior results with antiseptic-releasing IDB vs. other two IDB</li> </ul>	<ul style="list-style-type: none"> <li>Compared to MTB alone and floss, daily use of IDBs was effective in reducing interproximal plaque, gingivitis scores, and interproximal bleeding on probing</li> <li>Benefits evident at 2 wks, but more consistent at 4 wks</li> <li>The antiseptic-releasing IDB did not appear to confer a consistently independent incremental benefit</li> </ul>
<b>Schmage 1999</b>	Adults with gingivitis (35)	1 wk	MTB + IDB MTB + floss MTB + mechanical interdental cleaner	Proximal plaque PBI (bleeding) Interdental bleeding tendency on stimulation	<ul style="list-style-type: none"> <li>Overall reduction in average PBI</li> <li>Substantially less interproximal plaque remained after manual interdental cleaning (5%) compared with mechanical cleaning (40%)</li> <li>Cleaning efficiency of manual and mechanical methods was comparable in only one interproximal space size</li> <li>Interdental bleeding on stimulation significantly higher with mechanical manual cleaning at the end of the study</li> </ul>	<ul style="list-style-type: none"> <li>Manual interproximal cleaning was more effective than mechanical cleaning</li> </ul>
<b>Christou 1998</b>	Adults with moderate to severe periodontitis (prior to debridement) (26)	6 wks	MTB + floss MTB + IDB	Plaque Gingival inflammation Probing depth	<ul style="list-style-type: none"> <li>At 6 wks vs. baseline with MTB + IDB vs. MTB + floss:</li> <li>Significantly greater reduction in plaque</li> <li>Significantly greater reduction in probing depth/pocket</li> <li>Reduced bleeding with both interdental devices, with no significant differences</li> <li>Significantly greater patient acceptance with IDB; more problems experienced with floss, IDB felt to be more efficacious</li> </ul>	<ul style="list-style-type: none"> <li>MTB + IDB more effective in plaque removal and results in larger reduction of probing depth than MTB + floss</li> <li>Differences were small, but indicate that in combination with patient preferences, IDB preferable to floss for interdental plaque removal in patients with moderate to severe periodontitis</li> </ul>
<b>Bergen-holtz 1984</b>	Adults with periodontal disease (9)	8 wks	Floss IDB x 3 (crossover study)	Plaque	<ul style="list-style-type: none"> <li>No difference in achieved cleanliness after use of different IDB</li> <li>No gingival damage or damage to hard tissue of teeth observed with IDB or floss</li> </ul>	<ul style="list-style-type: none"> <li>IDB preferable to floss in cleaning interdental areas where the papilla is missing</li> </ul>



# INTERDENTAL CLEANING TO PREVENT AND TREAT GUM DISEASE: STATE OF THE EVIDENCE

## APPENDIX III

### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

SYSTEMATIC REVIEWS / META-ANALYSIS – Varied subjects						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Kotsakis 2018</b>	22 trials: Healthy (438) Gingivitis (1365) Periodontitis (74)	4-24 wks	Floss Powered flossing Toothpicks Toothpicks + intensive oral hygiene Water jet irrigation IDB Gum massagers MTB alone Powered TB alone Powered TB + water jet (10 total)	GI (gingival inflammation) BOP (bleeding) Plaque Probing depth	<ul style="list-style-type: none"> <li>IDB yielded largest reduction in gingival inflammation as toothbrushing adjuncts, followed by water jet</li> <li>Rankings based on posterior probabilities revealed that IDB and water jet had highest probability of being “best” for reduction of gingival inflammation</li> <li>Probability for toothpick and floss being the “best” aids was near zero</li> <li>Except for toothpicks, all aids were better at reducing GI vs. MTB alone</li> </ul>	<ul style="list-style-type: none"> <li>IDB and water jets ranked high for reducing gingival bleeding, whereas toothpicks and floss ranked last</li> <li>Patient-perceived benefit of aids is not clear because gingival inflammation measures are physical indicators of periodontal health</li> </ul>
<b>Salzer 2015</b>	6 systematic reviews	-	Floss (n=2 reviews) IDB (n=2) Woodsticks (n=1) Oral irrigator (n=1)	Plaque Gingivitis	<ul style="list-style-type: none"> <li>Moderate evidence that MTB + IDB reduces plaque and gingivitis</li> <li>Weak evidence of unclear or small magnitude that MTB + dental floss, woodsticks or oral irrigator reduces gingivitis, and no concomitant evidence for effect on plaque</li> </ul>	<ul style="list-style-type: none"> <li>IDBs most effective method for interdental plaque removal</li> <li>Majority of available studies fail to demonstrate that floss is effective in plaque removal</li> <li>However, all interdental devices support management of gingivitis to a varying extent</li> </ul>
SYSTEMATIC REVIEWS / META-ANALYSIS – Orally-healthy individuals						
Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Sambunjak 2011</b>	Healthy adults, prevention of gingivitis and dental caries (1083, 12 trials)	6 mo	MTB + floss MTB alone	Plaque Gingivitis	<ul style="list-style-type: none"> <li>Significantly greater reduction in gingivitis with MTB + floss vs. MTB alone at 1, 3 and 6 mo</li> <li>Small reduction in plaque at 1 or 3 mo with MTB + floss, but evidence is weak and very unreliable</li> </ul>	<ul style="list-style-type: none"> <li>Some evidence that MTB + floss reduces gingivitis compared to MTB alone</li> <li>People who brush and floss regularly have less gum bleeding compared to MTB alone</li> <li>Weak and very unreliable evidence of a small reduction in plaque with MTB + floss</li> </ul>



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### KEY RESULTS FROM RCTS COMPARING MANUAL INTERDENTAL PLAQUE CONTROL TO PREVENT AND TREAT GUM DISEASE

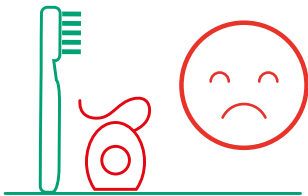
#### SYSTEMATIC REVIEWS / META-ANALYSIS – Patients with gingivitis or periodontitis

Study	Study characteristics				Key results	Author conclusions
	Patients (N)	Follow-up	Interventions	Key outcomes		
<b>Poklepovic 2013</b>	Adults (354, 7 trials)	4-24 wks	MTB + IDB MTB + floss MTB alone	Prevention of periodontal disease, plaque, dental caries	<p>MTB + IDB vs. MTB alone:</p> <ul style="list-style-type: none"> <li>• Very low-quality evidence from one study for a reduction in gingivitis at 1 mo, favoring of use of IDB</li> </ul> <p>MTB + IDB vs. MTB + floss:</p> <ul style="list-style-type: none"> <li>• Reduction in gingivitis in favor of IDB vs. floss at 1 mo in seven studies (low-quality evidence) (translates to 52% reduction in gingivitis)</li> <li>• Insufficient evidence to claim benefit for either IDB or floss for reducing plaque at 1 and 3 mo</li> </ul>	<ul style="list-style-type: none"> <li>• Only one study looked at whether MTB + IDB was better than MTB alone, and there was very low-quality evidence for a reduction in gingivitis and plaque at 1 mo</li> <li>• Also low-quality evidence from seven studies that IDB reduces gingivitis vs. floss at 1 mo</li> <li>• Insufficient evidence to determine whether IDB reduced or increased plaque levels compared to floss</li> </ul>
<b>Imai 2012</b>	Adults with periodontitis, gingivitis, or both (446 patients, 7 trials)	4-12 wks	MTB + IDB MTB + floss (after de-bridement)	Bleeding Plaque	<ul style="list-style-type: none"> <li>• Reduction of bleeding greater with MTB + IDB than MTB + floss (four studies)</li> <li>• Significant reduction in plaque with MTB + IDB vs. MTB + floss (seven studies)</li> </ul>	<ul style="list-style-type: none"> <li>• MTB + IDB effective alternative to MTB + floss for reducing bleeding and plaque between four and 12 wks</li> </ul>
<b>Slot 2008</b>	Adults with periodontitis (9 trials)	Up to 12 wks	MTB + IDB MTB alone or other interdental devices	Markers of periodontal inflammation (plaque, gingivitis, bleeding, pockets)	<ul style="list-style-type: none"> <li>• MTB + IDB removes more dental plaque than MTB alone, and is even more effective than dental floss or woodsticks</li> <li>• Positive significant difference using IDB with respect to plaque scores, bleeding scores and probing pocket depth; reduction of pocket depth more pronounced with IDB than floss</li> <li>• Positive significant difference in plaque index with IDB compared with floss</li> <li>• Evidence for effect on gingival inflammation less conclusive</li> </ul>	<ul style="list-style-type: none"> <li>• More dental plaque removed with MTB + IDB than MTB alone, floss or woodsticks</li> <li>• Inconclusive evidence for effect on gingival inflammation; no difference in effect of IDB on parameters of gingival inflammation compared to floss</li> <li>• Reduction of pocket depth with IDB more pronounced than with floss</li> </ul>

AngBI, angulated bleeding index; BOIP, bleeding on interdental brushing index; BOMP, bleeding on marginal probing; BOP, bleeding on probing (interdental sites); EIBI, Eastman interdental bleeding index; FMBS, full-mouth bleeding score; FMPS, full-mouth plaque score; GA, gingival abrasion score; GI, gingival index; GBI, gingival bleeding index; ICU, intensive care unit; IDB, interdental brush; MGI, modified gingival index; mo, months; MTB, manual toothbrush; OHIP, oral health impact profile; OR, odds ratio; PBI, papillary bleeding index; PI, plaque index; PPD, probing pocket depth; RIC, rubber interdental cleaners; RICL, relative interdental papillae level; RMNPI, Rustogi Modified Navy Plaque Index; TB, toothbrush; wk(s), week(s).

# WHY IS ORAL HEALTH still such a big challenge?

## BECAUSE...



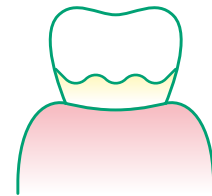
IT RELIES ON PATIENTS<sup>1</sup> and when it comes to interdental care, patient compliance is low.<sup>2</sup>

## IN THEORY



Clinical trials have clearly shown that an interdental cleaning strategy guided by patients' interdental spaces provides excellent results and helps prevent gum disease<sup>3</sup>.

## IN PRACTICE



Ineffective cleaning is common<sup>3</sup> as patients often do not follow recommendations from healthcare providers<sup>4</sup> and the prevalence of gum disease remains high.

## WHAT CAN WE DO?



## MAKE IT EASY FOR PATIENTS!

AND OPEN THE DOOR TO EFFECTIVE INTERDENTAL CLEANING

Less demanding methods of interdental cleaning increase motivation and patient outcomes<sup>5</sup>

Patients prefer soft rubber picks because they are easier and more comfortable to use, and cause less pain<sup>6</sup>

Soft rubber picks massage gums and clean between teeth without abrasion

## HELP YOUR PATIENTS MOVE UP THE ORAL CARE LADDER!



## GUM® SOFT-PICKS®

ORIGINAL

COMFORT FLEX

ADVANCED

