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Evidence-based strategies for interdental cleaning: a practical decision tree and review of the literature

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Objectives: Although several studies have investigated the effectiveness of various interdental cleaning devices, there is a need for an evidence-based synopsis for clinicians to customize interdental hygiene instructions and provide specific devices for each patient. This literature review aims to establish an evidence-based decision-making tree recommending individualized approaches to interdental cleaning based on embrasure size and patient-specific conditions. **Data sources:** Specific keywords related to interdental cleaning were used to search and identify the existing literature in PubMed and the Cochrane Library. Through a series of review processes, qualifying studies were identified and assessed with respect to the inclusion criteria to establish the decision tree. **Results:** A total of 27 studies were included to support a decision tree. Traditional dental floss continues to remain the first choice for individuals of high motivation and good manual dexterity with type I closed embrasures. For individuals with closed embrasures, but lack of motivation and/or dexterity, the use of easy flossers, soft picks, oral irrigation, and small (0.6 to 0.7 mm) interdental brushes are alternatives. For individuals with type II and type III open embrasure spaces, an interdental brush has the highest evidence for its effectiveness to remove interdental plaque. However, two studies showed that residual plaque could be found over lingual embrasures and thus lingual approach of the interdental brush is sometimes needed. The use of gum stimulators and/or woodsticks continues to be supported when significant gingival inflammation is present. **Conclusion:** Each patient should be individually assessed and given tailored oral hygiene home care instructions for the most effective outcomes. The proposed decision tree provides clinicians with an evidence-based guideline to help customize the use of interdental cleaning devices for each patient. *(Quintessence Int 2020;51:84–95; doi: 10.3290/j.qi.a45268)*

Key words: biofilm, decision tree, dental hygiene, evidence, interdental, tooth brushing

Optimal oral hygiene is necessary for oral and overall systemic health. Stagnant dental biofilm is the primary etiologic factor that increases the patient's risk of developing dental caries and periodontal disease.[1-4] Although tooth brushing has been proven to be successful at removing biofilm on buccal, lingual, and occlusal surfaces,[5,6] tooth brushing alone cannot reach and clean the interdental tooth surfaces effectively. This may result in pronounced biofilm accumulation in interproximal areas where periodontal disease predominantly originates.[5,7-9] Similarly, dental caries is also commonly found at interproximal surfaces as a bacteriologically mediated disease.[10-12] Interdental biofilm is more prevalent,[13] forms more readily,[14] and is more acidogenic than biofilm on other tooth surfaces.[7] As a result, dental caries in the interdental area remains one of the most common caries in daily clinical practice.[15] Therefore, an effective interdental cleaning strategy is needed, especially for those individuals with a higher risk of developing caries and periodontal disease.[16,17] Although dental floss remains the most commonly accepted and used interproximal cleaning device for removing the interdental biofilm, it may have some disadvantages with certain patients who have open interproximal embrasure spaces, lack of motivation, and limited manual dexterity. Furthermore, dental floss is tech-

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nique-sensitive and may need a clear demonstration from clinicians in order to be effective. Therefore, clinicians should individually assess each patient and recommend a specific interdental cleaning device in addition to personalized oral hygiene instructions to maximize the successful removal of interdental biofilms.

Method and materials

Literature selection and data extraction

The examiners (PL, SY, CW) conducted a literature search using specific keywords related to interdental cleaning in PubMed and the Cochrane Central Register of Controlled Trials. Comprehensive search strategies were established for inclusion in the review to support the evidence-based decision tree:

- "interdental cleaning" [All fields] AND "effectiveness" [All fields]
- "interdental cleaning" [All fields] AND "embrasure" [All fields]
- "dental floss" [All fields] AND "embrasure" [All fields]
- "interdental brush" [All fields] AND "embrasure" [All fields]
- "woodstick" [All fields] AND "embrasure" [All fields]
- "oral irrigation" [All fields] AND "embrasure" [All fields]
- "rubber interdental bristle" [All fields] AND "embrasure" [All fields]
- "interdental cleaning" [All fields] AND "motivation" [All fields]
- "dental floss" [All fields] AND "motivation" [All fields]
- "interdental brush" [All fields] AND "motivation" [All fields]
- "woodstick" [All fields] AND "motivation" [All fields]
- "oral irrigation" [All fields] AND "motivation" [All fields]
- "rubber interdental bristle" [All fields] AND "motivation" [All fields]
- "interdental cleaning" [All fields] AND "dexterity" [All fields].

The screening in such databases was limited to "meta-analysis" OR "systematic review" OR clinical trials" OR "case reports" AND "human" subjects. Additionally, the keywords "easy flosser," "flosspik," and "gum stimulator" were searched separately through manual screening on the two major electronic databases (PubMed and the Cochrane Central Register of Controlled Trials) to fulfill the outcome of interest. Initial screening of electronic databases yielded a total of 3,430 articles from year 1970 to 2019. After removal of duplicate articles and only inclusion of "human" subjects, 1,002 articles were screened. Out of 1,002 articles, 827 were excluded based on titles and abstracts. The screening flowchart is presented in Appendix 1 (available at https://qi.quintessenz.de). A total of 27 critical studies were included, presented in Table 1, to propose the referenced decision tree in this study (Figs 1 to 3).

Review of the literature and reference-based decision tree

Over the last several decades, many clinical studies have been conducted on the effectiveness of interdental cleaning devices. However, the outcomes of these studies have not been consolidated in a manner that helps clinicians make an evidence-based decision to formulate personalized oral hygiene home care treatment plans. Therefore, the aim of this narrative review was to create a consolidated evidence-based decision tree for interdental cleaning. The decision tree was created based on the following categories:

- embrasure size
- patient motivation
- manual dexterity
- biofilm accumulation pattern.

The hierarchy of the research design in each study was scrutinized to provide the level of evidence to support the decision tree. Table 1 is organized according to the hierarchy of study design as the following:

- IA (red): Meta-analysis and/or systematic review
- IIA (blue): Randomized controlled trials
- IB (green): Nonrandomized controlled trials.

The studies with their corresponding letters and colors are included in Figs 1 to 3 to support the decision making.

The interdental cleaning decision tree seen in Fig 1 demonstrates stratification of space type according to different sizes of embrasure, which can be classified by either intact papilla or reduced papilla. For the purpose of this study, embrasure type I is defined as closed interdental space filled with interdental papilla, and is most commonly seen in young and healthy patients. Embrasure type II is defined as an open interdental space where the interdental papilla fills roughly 51% to 75% of the space. Type III represents a more open interdental space where the interdental papilla fills up to 50% of the space.[44] Type II and type III open embrasures are commonly seen in the aging population,[19,20] in patients who present with receding gingiva, or in those with a history of or currently active periodontal disease.

Based on the review of the aforementioned literature, an evidence-based decision tree was formulated. After local plaque retentive factors are identified, the interdental embrasure size is the major determinant for selecting appropriate devices (Fig 1). For individuals with type I closed embrasure space, high motivation, and good manual dexterity, dental floss remains the initial recommendation for interdental clean-

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Table 1 Studies on various interdental cleaning devices

Study	Study type	Subjects/ measurement index	Results/findings	Conclusion	Level of evidence
Sälzer et al[18]	Meta-analysis	395 studies included	Studies showed a positive significant difference on the PI when using IDB compared to flossing.	IDBs of the appropriate size should be the first choice providing interdental spaces are accessible.	IA
			IDB results in 34% reduction in gingivitis and 32% reduction in plaque vs tooth brushing alone.	IDB is the most effective method for interdental plaque removal.	
Van der Weijden and Slot[19]	Meta-analysis	33 studies included	IDBs as an adjunct to brushing alone showed a significant difference in favor of the use of IDB for plaque removal (n = 3 studies).	Selection is most dependent on the size and shape of the interdental space, and morphology of the proximal tooth surface.	IA
			Positive significant difference on the PI when using IDB vs DF (n = 5 studies).	The best available data suggests the use of IDB for interdental cleaning and should be the first choice in patients with open interdental spaces.	
			Positive effect on pocket reduction in periodontal patients when compared with DF (n = 2 studies).		
Sambunjak et al[20]	Meta-analysis	12 studies included	Flossing plus tooth brushing showed a statistically significant benefit compared to tooth brushing in reducing gingivitis at the 3 time-points studied (1 mo, 3 mo, 6 mo).	Flossing in addition to tooth brushing reduces gingivitis compared to tooth brushing alone, especially at 6 mo.	IA
Slot et al[21]	Systematic review	9 studies included	The IDB removes significantly more dental plaque than DF or woodsticks.	In patients with large embrasure spaces, the IDB reduced PDs, bleeding scores, and had superior plaque reducing abilities compared to DF.	IA
			No difference in the effect of IDB on parameters of gingival inflammation as compared to DF.		
Husseini et al[22]	Systematic review	7 studies included	There is a positive adjunctive effect of OI on the GI and bleeding score in 3 studies, and PD in 2 studies.	As an adjunct to brushing, the OI does not have a beneficial effect in reducing visible plaque but significantly improved bleeding scores and gingival health.	IA
Hoenderdos et al[23]	Systematic review	8 studies included	In comparison to brushing alone, woodsticks provided a significant additional effect on reduction of bleeding scores (n = 3 studies)	Woodsticks improve interdental gingival inflammation by reducing the bleeding tendency.	IA
Kotsakis et al[24]	Systematic review	22 studies included	IDB as a tooth brushing adjunct yielded the largest reduction in GI. Water-jet also showed a significant reduction in GI over adjunct toothpicks and DF.	Both IDB and water-jet as tooth brushing adjuncts showed a significant reduction in GI, whereas toothpicks and water-jet as tooth brushing adjuncts showed a significant reduction in BOP.	IA
			Toothpick with intensive oral hygiene instruction achieved the greatest BOP reduction, followed by water-jet in comparison to control of only using toothbrush.	Practitioners should customize interdental oral hygiene aid recommendations and offer alternatives for each patient.	
Hennequin-Hoenderdos et al[25]	Systematic review	4 studies included	No significant difference between IDB and RIBB cleaners for plaque indices.	No difference between IDB and RIBB on various outcomes related to gingival health or plaque levels.	IA
			One study found a positive effect in favor of RIBB for gingivitis patients to reduce gingival bleeding.	The RIBB could be an alternative for an IDB in gingivitis patients.	
Imai and Hatzimanolakis[26]	RCT	N = 33 patients (IDB: n = 224 sites; DF: n = 223 sites). Control: soft manual toothbrush with waxed DF. Experimental: soft manual toothbrush with IDB. Follow-up period: 6, 12 wk.	One way ANOVA showed statistically significant reduction in mean bleeding sites with IDB compared with DF ($P = .01$).	IDB (min. 0.6 mm) significantly reduces bleeding sites in patients with Type I embrasures.	IIA
			There was no statistical difference between plaque site reduction for IDB and DF ($P = .93$).	Both DF and IDB significantly reduced plaque over 12 wk.	
			Mean bleeding was significantly reduced with IDB vs DF at wk 12 ($P = .01$).		
Stauff et al[27]	RCT	N = 60 patients. Control: interdental home cleaning regime with DF (n = 20). Experimental: interdental home cleaning regime with microdroplet device (n = 40). Follow-up period: 4 wk.	Microdroplet device and DF both reduced gingivitis ($P < .05$). The microdroplet device was more effective at reducing plaque ($P = .003$).	Acceptance regarding comfort of use was higher with the microdroplet device.	IIA
			About 85% of participants agreed that using microdroplet device is more comfortable.	DF remained the first choice for narrow interdental spaces, yet the microdroplet device offers an effective and well-accepted alternative for patients who fail the proper flossing routine.	
Gjermo and Flötra[28]	Cohort Study	N = 16 patients. Three experimental studies with different interdental cleaning devices: 1) DF; 2) Toothpicks; 3) IDB. Follow-up period: 4 wk.	Three experimental studies compared the effects of DF, toothpicks/woodstick, and IDB for interdental cleaning.	In healthy periodontal tissues, DF was superior to toothpicks in removing plaque from the lingual interproximal surfaces.	IIA
			In wide-open interproximal areas, IDB showed most removal of dental plaque.	In wide-open interproximal areas with periodontal destruction, IDB is the most suitable to remove dental plaque.	
Bergenholtz and Olsson[29]	Cohort study	N = 9 patients. Control: Waxed DF. Experimental: 1) Long-mini size of IDB; 2) Short-mini size of IDB; 3) Dense IDB. Follow-up period: 8 wk.	Use of IDB was preferred over DF to clean open interdental spaces.	IDB is preferred over DF to clean interdental areas where the papilla is missing (open).	IIA
			IDB and DF did not damage gingival or hard tissue.	Less plaque remained after use of the three tested IDB, than after DF.	
Christou et al[5]	RCT	N = 26 patients. Control: DF for one side. Experimental: IDB for the other side. Follow-up period: 6 wk.	IDB resulted in a greater pocket reduction.	IDB proved to remove significantly more plaque and greater pocket reduction than DF.	IIA
			Both IDB and DF slightly reduced bleeding indices and proximal plaque score.	IDB found to be more efficacious, more patient acceptance, less problems.	
				Patient reported "more problems with DF. IDB felt more efficacious."	
Imai and Hatzimanolakis[30]	RCT	N = 32 patients. Control: toothbrush. Experimental: 1) DF; 2) IDB. Survey collected information about patients' perceptions and preferences for DF and IDB. Follow-up period: 6 wk.	96.7% of the study patients agreed that the IDB was easy to use ("strongly agreed" or "agreed").	Patients were more than twice as likely to "strongly agree" that IDB was easy to use compared to DF, with 40% having neutral opinions about DF ease of use.	IIA
			Some stated that "IDB was easier to use even with a busy schedule and was faster than DF."	Compliance is associated with the ease of use and motivation of IDB.	
			Other patients commented, "I can reach parts [with the IDB] that I find difficult to clean with DF."		

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Study	Study type	Subjects/ measurement index	Results/findings	Conclusion	Level of evidence
Ishak and Watts[31]	RCT	N = 10 patients. Split-mouth method. Control: patients used DF for one side. Experimental: IDB for the other side. Follow-up period: 1 mo.	The mean proximal plaque score reduced supraginigvally from 14.5 to 5.7 with IDB and from 12.9 to 5.3 with DF; subgingivally the score reduced from 17.3 to 6.7 and 16.7 to 8.1, respectively ($P < .001$).	Patients prefer IDBs because they were "simpler to use."	IIA
				BOP and mean probing depth reduced over time for IDB sites, but not DF sites. ($P < .01$).	
Burch et al[32]	RCT	N = 47 patients. Subjects: patients with fixed orthodontic appliances were divided into three groups: Control: 1). Normal tooth brushing only. Experimental: 2) OI with automatic toothbrush; 3) OI with manual tooth brushing. Follow-up period: 1, 2 mo.	The use of both automatic toothbrush and oral irrigation reduced the PD significantly from baseline by 0.5 mm ($P < .0002$).	For orthodontic patients, automatic toothbrush and OI significantly reduced plaque, gingival inflammation, and BOP in both experimental groups with the power device.	IIA
				These improvements were most attributable to the effect of the OI device.	
Hoenderdos et al[33]	RCT	N = 42 patients. Control: RIBB as adjunct to manual tooth brushing. Experimental: IDB as adjunct to manual tooth brushing. Follow-up period: 1, 2, 4 wk.	No significant difference between RIBB and IDB reducing BOP and dental plaque score.	In accessible sites, RIBB in conjunction with manual tooth brushing, was more effective in reducing gingival inflammation and BOP.	IIA
			RIBB showed significantly less BOP after 4 wk ($P = .009$) and caused less gingival abrasion ($P > .016$). It was also considered more pleasurable to use by the participants ($P = .0001$).	RIBB caused less gingival abrasion and was more appreciated by the participants.	
Yankell et al[34]	RCT	N = 64 patients. Control: Oral-B 35 manual toothbrush. Experimental: Stimu-gum device. Follow-up period: 15, 30 d.	BOP scores continued to be lower in the gum stimulator group vs only tooth brushing at 30 d.	Gum stimulator device was significantly more effective than the Oral-B toothbrush in reducing gingivitis scores at 30 d and BOP at 15 d.	IIA
			Differences were not statistically significant compared to the Oral-B mean scores.	BOP scores continued to be lower in the gum stimulator group at 30 d.	
Bergenholtz and Brithon[35]	Cohort study	N = 10 patients. Control: nylon DF; silk DF; super DF. Experimental: triangular toothpicks for interdental tooth cleaning. Follow-up period: 2 wk.	Plaque accumulation assessed in an intraindividual study after using nylon DF, silk DF, super DF, or triangular toothpicks.	DF had a higher plaque removing potential than triangular toothpicks, especially on lingual axial surfaces.	IIA
			No significant data provided.		
Lewis et al[36]	RCT	N = 47 patients. Control: DF (n = 27). Experimental group: toothpick holder using group (n = 20). Follow-up period: 2, 6, 12 wk.	Mean O'Leary plaque scores decreased significantly for DF and toothpick holder from baseline to wk 12 ($P < .05$).	Use of DF or toothpick holder significantly decreased Mean O'Leary plaque scores and EIBI.	IIA
			EIBI and IPI mean scores decreased over time for each method ($P < .05$).	DF and toothpick holder did not improve gingival health with a significant difference.	
			A correlation was found between the O'Leary PI and the IPI scores ($P < .05$).		
Bourgeois et al[37]	RCT	N = 46 patients. Control: standard manual toothbrush. Experimental: manual toothbrush twice daily and IDB daily. Follow-up period: 1 wk, 1 mo, 3 mo.	Preventive fraction with respect to bleeding frequency was 46% at 1 wk and 72% at 3 mo.	Daily use of calibrated IDB reduces interdental bleeding.	IIA
			More bleeding reduction was observed in anterior sites (80%) than in posterior sites (69%).	Interdental cleaning is an effective means to help individuals maintain and/or achieve optimal oral health.	
Yost et al[38]	RCT	N = 120 patients. Four different interdental cleaning devices: 1) DF (Glide DF); 2) Easy flosser (Butler flossers); 3) IDB (GUM Go-Betweens cleaners); 4) RIBB (GUM Soft-Picks cleaners). Follow-up period: 3 wk, 6 wk.	All four products showed significant plaque reduction when used in conjunction with tooth brushing.	DF was the recognized "gold standard" for gingivitis reduction and was matched in performance by flossers and a RIBB but surpassed by an IDB.	IIA
			The Go-Betweens cleaners showed a significantly greater GI reduction than the other three products on the buccal aspect.		
Costa et al[39]	Cohort study	N = 142 patients. Three groups: 1) Brushing + DF; 2) Brushing + DF + IDB; 3) Brushing + DF+ OI. Follow-up period: two time-points: 1) after active periodontal therapy; 2) 6-y follow-up.	Recurrence of periodontitis was significantly higher among brushing + DF group when compared with manual brushing +DF + IDB and manual brushing + DF + OI groups.	Brushing + DF + IDB and brushing + DF + OI individuals presented lower rates of recurrent periodontitis and better periodontal condition when compared to brushing + DF individuals.	IIA
Abouassi et al[40]	RCT	N = 39 patients. Two groups: RIBB and MCIB. Follow-up period: 4 wk.	Both groups showed a significant decrease in plaque; bleeding was significantly reduced after 4 wk for both groups.	RIBB were similarly effective compared to the interdental brushes.	IIA
			RIBB had higher patient acceptance scores in relation to assessment for less pain during usage, comfort of brushing, and willingness to buy the product.	RIBB was significantly more comfortable for participants than using MCIB.	
Graziani et al[41]	RCT	N = 60 patients. Control: manual toothbrush alone. Experimental: 1) manual toothbrush + DF; 2) manual toothbrush +IDB; 3) toothbrush + RIBB. Follow-up period: 4 wk.	Interdental FMPS showed significantly lower values in patients treated with IDB or RIBB vs tooth brushing alone ($P < .05$).	For patients with no interdental attachment loss, tooth brushing, or tooth brushing and adjunctive interdental cleaning devices (DF, IDB, or RIBB) can significantly reduce both plaque and gingival inflammation.	IIA
			Use of interdental picks was associated with reduced interdental FMBS when compared to DF ($P < .05$).		
Carrouel et al[42]	Case series	N = 99 patients. Subjects: 18–25-y-old adults free of periodontal disease. The interproximal dental spaces were examined using a colorimetric calibrated probe.	Overall accessibility of any IDB had prevalence of 92.3% (2,408/2,608 sites).	Most interdental sites can be cleaned using IDB (0.6–0.7 mm).	IB
			In total, 80.6% of the sites required the smaller diameter (0.6–0.7 mm) IDB.	Interdental hygiene requirements are very high even in healthy people.	
				Screening of the accessibility of the interdental space should be a component of a routine examination for all patients.	
Kiger et al[43]	Case-control study	N = 30 patients. Control: toothbrush only. Experimental: 1) toothbrush + DF; 2) toothbrush +IDB. Follow-up period: 1 mo.	Statistically significant differences were seen in mean proximal plaque scores between the 3 treatment groups (tooth brushing only, tooth brushing with DF, and tooth brushing with IDB).	IDB significantly reduced more interproximal plaque than DF	IB
				Patients found "DF more difficult and technically demanding in spite of repeated instructions. IDB [was] easier and more comfortable."	

BOP, bleeding on probing; DF, dental floss; EIBI, Eastman Interdental Bleeding Index; FMBS, full-mouth bleeding score; FMPS, full-mouth plaque score; GI, gingival index; IDB, interdental brush; IPI, Interproximal Plaque Index; MCIB, metal-core interdental brush; min., minimum; OI, oral irrigation; PD, probing depth; PI, Plaque Index; RIBB, rubber interdental bristle.

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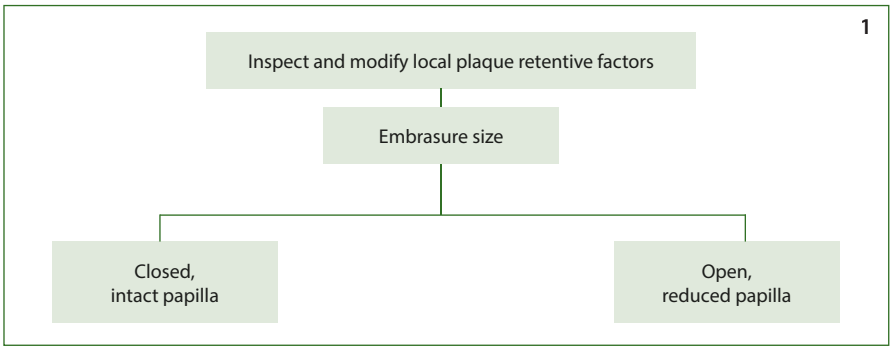

Fig 1 Embrasure size as the first differentiating factor after local plaque retentive and contributing factors are addressed.

ing at home. However, for those patients who present with type I closed embrasure (Fig 2) but low motivation and/or lack of manual dexterity, a small diameter (0.6 to 0.7 mm) interdental brush (IDB) should be recommended as the first choice as long as the size of interdental embrasure space allows its passive insertion. Otherwise, alternatives including rubber interdental bristle (RIBB), easy flosser, or oral irrigation are recommended. For populations wearing orthodontic appliances, oral irrigation is highly recommended as an adjunct.[32]

For individuals with type II and type III open embrasures (Fig 3), it has been reported that IDBs are capable of reaching interdental spaces to reduce biofilm accumulation and gingival inflammation in filled open embrasure spaces. Therefore, IDBs should be the first recommendation for all individuals who present with open type II or type III embrasures regardless of motivation level and/or manual dexterity level (indicated by a red line in Fig 3). In addition, the woodstick and gum stimulator have demonstrated reduced interdental gingival inflammation and reduced bleeding tendency in individuals with type II and type III open embrasures.[34] Hence, the woodstick is included in the decision tree for type II and type III open embrasure as an effective adjunctive device, but may not be used as the sole home care aid. Finally, it was commonly observed that residual plaque could accumulate over lingual embrasures when using IDBs or woodsticks, because they are typically used from the buccal aspect. Thus, it is critical to examine the lingual embrasure and to introduce a c-shape dental flossing technique and IDBs from a lingual approach if necessary to address residual plaque in the lingual embrasure spaces.[35]

Discussion

The interdental space is defined as the space present between two adjacent teeth. The space and shape of this space is determined by the morphology of the teeth. The col is an area of nonkeratinized tissue sheltered between the buccal and lingual aspect of the marginal gingiva and lies apical to the contact point of adjacent teeth, thus making it difficult to access.[47] The nonkeratinized tissue of the col is easily destroyed during the pathogenesis of periodontitis.[48] Patients should be able to effectively remove biofilm from this susceptible area. The most appropriate cleaning device must be selected in relation to the embrasure size, patient's manual dexterity, degree of motivation, and biofilm accumulation pattern.[18,19]

Cause-related therapy proposed by Kwon and Levin[49] consists of five steps to specifically target the primary etiologic factor, dental biofilm, for periodontal disease and dental caries. When a patient's effective daily removal of biofilm is combined with professional interventions (ie, removing caries lesions and professional debridement of supra- and subgingival biofilm and calculus), periodontal disease and dental caries can be prevented and treated successfully.[49,50] First, clinicians should help patients understand the cause of the diseases, explain biofilm, and educate them on how to effectively remove the biofilm.

Closed type I embrasure

For individuals with type I closed embrasures, high motivation, and good manual dexterity, dental floss continues to remain the best choice for interdental care. A review by Sambunjak et al[20] reported the outcomes from 12 studies concerning interdental care through flossing. The review concluded that flossing, in addition to tooth brushing, significantly reduced gingivitis and plaque relating to periodontal diseases as compared to tooth brushing alone at 1 month, 3 months, and 6 months.[20] Although there are limited controlled prospective studies assessing the effect on reducing bone loss, the reduction of plaque and inflammation is highly likely to prevent periodontal disease occurrence in the long term. When the interdental papilla fills almost all of the interdental space, leaving only a very small embrasure

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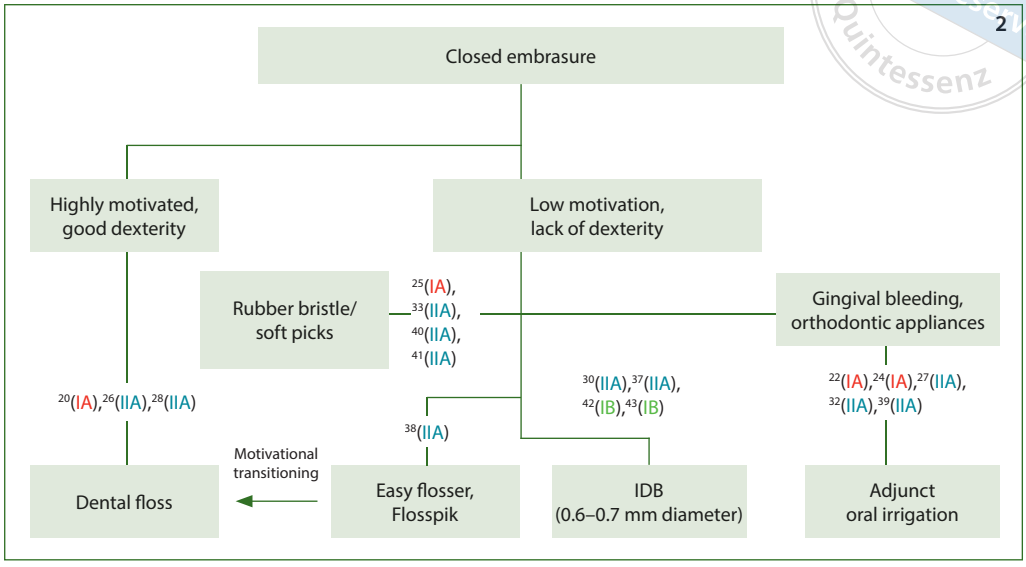

Fig 2 Evidence-based decision tree for interdental cleaning for closed embrasures (see Table 1 for references with level of evidence). IDB, interdental brush.

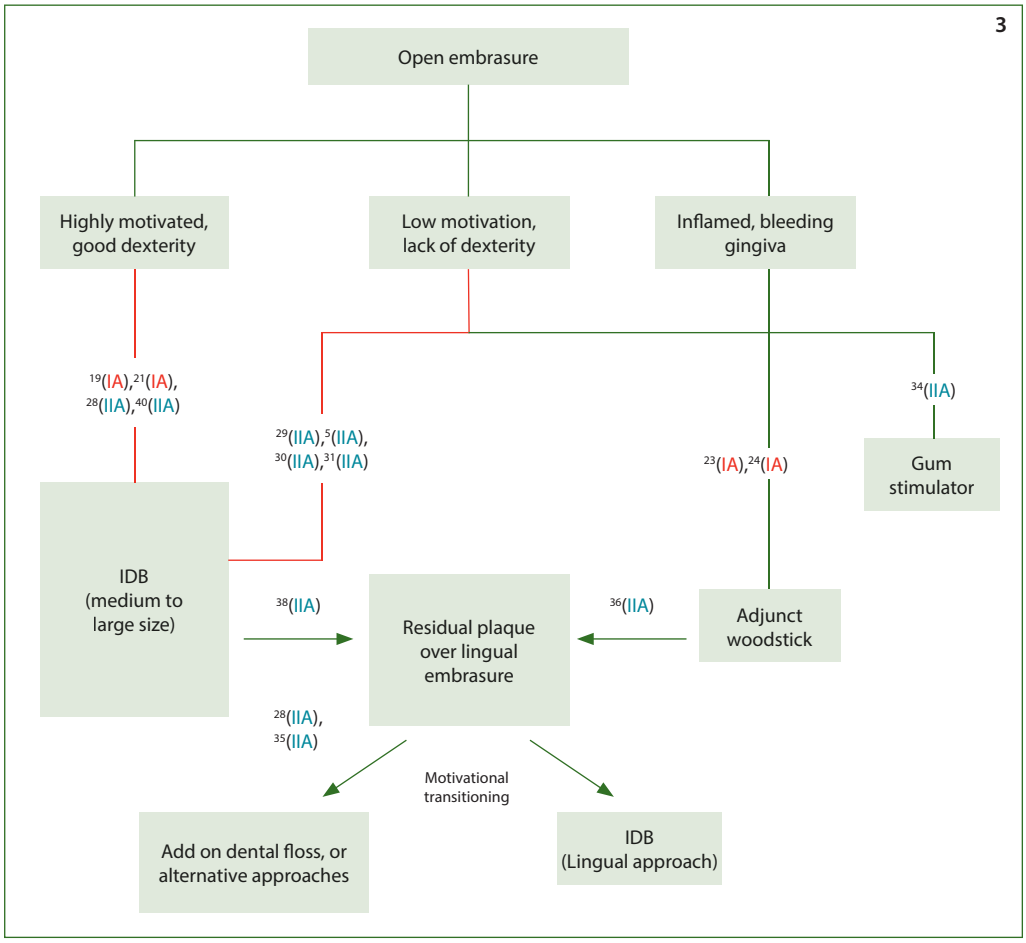

Fig 3 Evidence-based decision tree for interdental cleaning for open embrasures. Interdental brush (IDB) as the decision is highlighted with a red line, supported by the most references (see Table 1 for references with level of evidence). This should be recommended as the first choice for most patients.

opening, dental floss has been determined as the most suitable interdental cleaning device.[18] However, for individuals with type 1 closed embrasures who lack motivation or have manual dexterity disabilities, interdental cleaning devices beyond traditional floss should be considered.[26] Nonetheless, patient acceptance is a major factor to accomplish the intended outcomes of

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Fig 4 The use of easy flosser can be an alternative option to floss string if the patient never flosses. This picture was exported from a customized oral hygiene instructional video for a patient who never flossed.

interdental cleaning devices.[51] Therefore, to determine the effectiveness of interdental cleaning methods, clinicians need to clinically assess biofilm accumulation patterns and evaluate patient compliance and acceptance through patient interview.[19,51,52] Positive feedback for patients' flossing effort and planning intervention are effective ways to change patients' oral home care behavior and to encourage compliance.[53]

A study that surveyed American adults reported the daily use of dental floss was as low as 10% to 30%.[54] The same report indicated the main reason for such low compliance was the patient's lack of manual dexterity and motivation.[54] With this in mind, an easy flosser can be recommended to the patient who presents with low motivation and/or low manual dexterity to reduce interdental plaque and bleeding indexes (Fig 4).[36] Additionally, it has been reported that in comparison to traditional dental floss, the use of IDB to clean the interdental space is easier and had fewer reported problems, especially in posterior sites with inherently difficult access.[5,26,30,31] Two studies reported successful outcomes for patients with type I closed embrasures when using a small diameter (0.6 to 0.7 mm) IDB for cleaning the interproximal areas.[26,42] It can be concluded that for individuals with type I closed embrasure who show minimal to no motivation, a small diameter IDB should be recommended as an effective alternative to traditional dental floss.

Oral irrigation has also been reported as an oral home care device that can be used for adjunct interdental cleaning. Although systematic reviews published in 2008[22] reported no significant differences in reducing visible biofilms between subjects who used an oral irrigator as an adjunct to tooth brushing versus those who brushed alone, three of the included studies reported statistically significant reductions in bleeding upon probing.[55-57] A systematic review concluded that the inclusion of an oral irrigator during home care routines demonstrated a positive trend in improving gingival health over tooth brushing alone.[22] A few studies also evaluated the efficacy of oral irrigation in addition to regular tooth brushing and showed a higher acceptance concerning patient comfort.[22,27] A systematic review in 2018 concluded that using oral irrigation in conjunction with IDBs significantly reduced the Gingival Index, and using an oral irrigator along with toothpicks significantly reduced gingival bleeding.[24] An additional study evaluated the use of an electric toothbrush in conjunction with the use of an oral irrigator among adult orthodontic patients. This study reported significant reductions in plaque, gingival inflammation, and bleeding.[32] For patients with lack of motivation and manual dexterity or patients presenting with orthodontic treatment, alternative interdental cleaning options such as oral irrigation are necessary. Therefore, as seen in Fig 2, oral irrigation can be recommended as an adjunct to tooth brushing for individuals with closed type I embrasures and who lack motivation and/or demonstrate physical manual dexterity disabilities, or wear orthodontic appliances.

The RIBB can be utilized for individuals with lack of motivation and/or manual dexterity as studies have demonstrated higher patient acceptance scores and that patients felt this device was less painful and more comfortable.[40] It has also been demonstrated that use of the RIBB can provide significant reductions in both dental plaque and gingival inflammation, and has similar effectiveness when compared to the IDBs.[33,40,41] Therefore, the RIBB can be suggested as an alternative oral aid in patients with gingivitis.[25]

Open type II and III embrasures

A 2008 systematic review by Berchier et al[8] concluded that when the IDB was used regularly, probing depths and bleeding upon probing were reduced. The same study reported that when used regularly the IDB had superior biofilm reducing abilities compared to use of dental floss alone, specifically in subjects with large embrasure spaces.[8] A more recent meta-analysis by Sälzer et al[18] reported that the main advantage of an IDB is the ability to reach anatomical interdental grooves or fissures, which cannot be mechanically reached by any other interdental cleaning devices. The daily use of properly sized IDBs as an adjunct to tooth brushing can help patients maintain and/or achieve optimal oral health.[19,37] Additionally, a systematic review reported that the use of woodsticks as an adjunctive oral aid could reduce

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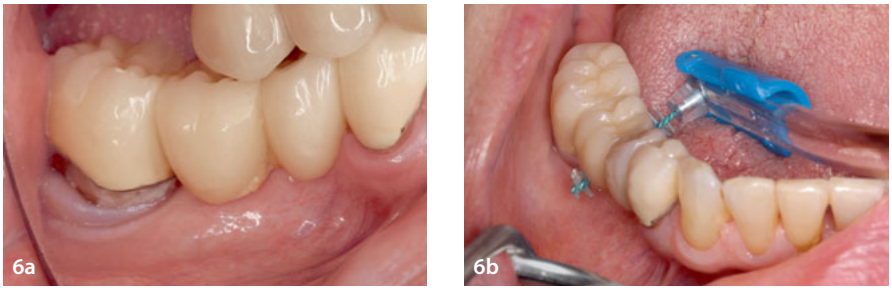
Figs 5a to 5d *(a)* A dental wedge woodstick in use. The tip of the triangle should be inserted right under the contact point and the wedging gently flattens the papilla. *(b)* Papillary inflammation with periodontal pocket of 6 mm with active bleeding on probing was present between mandibular left canine and premolar even after scaling and root planing. *(c)* A reduction in swelling and inflammation was noted at the 1-week follow-up after diligent daily use of a woodstick. *(d)* Complete resolution of the gingival inflammation and deep periodontal pocket at 2-week follow-up.



Figs 6a and 6b *(a)* Significant plaque accumulation over the mesial cervical area of a distal abutment tooth for a fixed partial denture, a common area with difficult access. *(b)* The best approach for this specific patient was to use not only a long-shank proxy brush but also a lingual approach due to the high tissue level and wide lingual embrasure surface that could not be reached through the buccal side.

the tendency for gingival bleeding, and demonstrated a significant reduction of bleeding upon probing; hence, gingival inflammation was reduced.[23] A randomized clinical trial demonstrated that woodsticks work by depressing the edematous interproximal gingiva by up to 2 mm, and therefore can clean areas of the subgingival space when sufficient interdental space is available (Fig 5).[58]

Both IDBs and woodsticks are easier and more convenient to use than dental floss.[59] Many studies found that patients reported IDBs were easier to use, exhibited higher motivation, and increased compliance compared to dental floss.[5,30,31,43] In addition, IDBs were more effective in removing dental plaque and interproximal gingival inflammation than dental floss and woodsticks, especially in open embrasure areas.[21,23,29,60,61] Therefore, as seen in Fig 6, IDBs should be the first recommendation for individuals who present with type II and type III open embrasures. This is applicable for individuals with or without compliance, as well as those with limited manual dexterity. It can be concluded that, although there are benefits to using the woodstick, they should be recommended solely as an adjunctive interdental cleaning device in addition to the more proven IDBs for patients who present with type II and type III open embrasures, regardless of motivation and manual dexterity.

The general instructions for IDBs and woodsticks are to move the device in and out from the buccal and lingual aspects of the interdental area. One unique approach of IDBs is that the device can be bent at the plastic shank, or the handle used (Fig 6), for a lingual approach. It will be critical to provide such unique use instructions to ensure the effectiveness of the IDB for an open embrasure. One study specifically compared the effect of IDB on buccal and lingual surfaces and found that plaque removal on the buccal surfaces was more effective with the use of IDB than

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on the lingual surfaces.[38] Another study reported significant improvement in gingival scores on the buccal side in comparison with lingual surfaces when using IDBs versus a rubber cone stimulator.[62] This may result in more residual plaque over the lingual aspect of the interdental embrasure. Therefore, it is important for clinicians to address and provide additional instruction to target residual plaque found in lingual embrasures. One of the advantages of utilizing floss if used correctly with the c-shaping technique is that it could remove more plaque than woodsticks around the lingual interdental embrasure surfaces.[28]

There are some limitations concerning this narrative review and reference-supported decision tree. First of all, although a systematic search was performed, systematic reviews and meta-analysis were not performed specifically at each juncture point for the decision tree. In addition, this study only suggests the use of specific interdental cleaning devices but does not include the approach on teaching patients how use each device. Patients present with individual challenges and each person should be evaluated and educated in how to properly use an interdental cleaning aid that best fits their needs and abilities. Using hands-on demonstration with a hand-held mirror and the disclosing agent can serve as effective teaching tool aids to educate patients on how and where they need to focus their interproximal cleaning strategies. This teach-back technique will help to ensure effectiveness as well as establish patient rapport and overall compliance.

Conclusion

This study provides an evidence-based clinical decision tree for both dental practitioners and patients concerning interdental oral hygiene home care. Based on most studies, if the embrasure space allows, IDBs should be considered as the first choice of interproximal cleaning aid. It is recommended that future longitudinal clinical investigations include patient-reported outcomes and compliance in order to prove the validity and reliability of the proposed decision tree.

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Appendix 1

Literature review search workflow