Dental Floss Selection and Its Impact on Evaluation of Interproximal Contacts in Licensure Exams


Abstract: Ideal interproximal contacts between adjacent natural teeth or dental restorations are a critical factor for the health and longevity of the dental-alveolar complex. Interproximal contact tightness is a physiological entity affected by many patient-related and restorative parameters. This variation poses a challenge in defining the “clinically acceptable” contact area tightness (CAT) and therefore how students and clinicians should be trained to evaluate this parameter. The most widely used method to evaluate interproximal contacts is to pass dental floss between contact areas. Candidates for licensure exams are instructed to check contact areas with dental floss and are advised that this will be one of the crucial parameters to be evaluated in the overall restoration quality. The purpose of this study was to evaluate a standardized interproximal contact with six brands of dental floss. Thirty faculty members and thirty dental students at one U.S. dental school evaluated the tightness of a single interproximal contact on a typodont. The results showed that no difference was found between CAT evaluations by faculty and students, whereas significant differences were found between different floss brands. In light of the results, it is suggested that licensure boards should standardize the recommendation for which floss brand should be used in order to avoid inconsistencies in students’ preparation.

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Ideal interproximal contacts between adjacent natural teeth or dental restorations are a critical factor for the health and longevity of the dental-alveolar complex. These contacts are frequently mentioned as “contact points”; however, G.V. Black wrote at the beginning of the twentieth century that these contacts consist of an area with well-defined morphology that should be preserved.1 Investigators have suggested that periodontal disease may be a consequence of open interproximal contacts; this contributes to food impaction and increased pocket depths2 and has been shown to be associated with inflammation, alveolar bone loss, increased probing depth, and periodontal attachment loss.3,4 Interproximal contact tightness has also been shown to impact loads on implants restored with single crowns5 and may affect jaw movements.6 A systematic review of the link between flossing and caries in children concluded that professional flossing in children is highly effective in reducing the incidence of interproximal caries.7 Clearly, the ability to perform this procedure depends on the shape and degree of firmness of the contact areas in the dentition. Incidence of caries has also been found to positively correlate with weak contact areas.8

Interproximal contact tightness is a physiological entity affected by the location of the teeth in the jaws,9,10 diurnal variations,11 patient position,9 occlusion and parafunction,6,10-12 and restorative techniques.13-19 This intra- and inter-individual variation causes the dental profession to face a challenge defining the “clinically acceptable” contact area tightness (CAT) and therefore how students and clinicians should be trained to evaluate this parameter.

The most widely used method to evaluate interproximal contacts is to pass dental floss between contact areas. The amount of force required to pass the floss through the contact area is the parameter used to evaluate the contact quality between adjacent teeth. This method was mentioned by G.V. Black, who suggested the use of waxed silk floss for this purpose.20,21 The optimal tightness of the proximal contact was defined as a “snap” as the floss passed through the contact point.9 Although one article
mentioned that U.S. Public Health Service criteria published in 1980 recommended evaluation of contact tightness with dental floss,16 a reprint of these criteria did not include this method.22 The FDI World Dental Federation calls dental floss a “less precise” method that “cannot be trained and calibrated by pictures” but is considered practical in the clinic for CAT evaluation.23 These criteria do not mention what type of floss should be used.

Metal shim stock has been described as an accurate method to determine ideal interproximal contact,9,16,25,24 but it is not a practical method to be used in a dental practice. Another method mentioned in conjunction with clinical research is the Tooth Pressure Meter that provides an objective reading; this device records the force needed to remove a metal strip from the proximal contact. It should be noted, however, that there is no consensus as to what the optimal thickness of the metal strip should be; researchers used strips with thicknesses ranging from 0.03 mm to 0.05 mm.9,10,14,15,25

Candidates for the Western Regional Examining Board (WREB) licensure exam are instructed to check the contact areas of the restoration with “Floss & Go” waxed dental floss and are advised that this will be one of the crucial parameters to be evaluated in the overall restoration quality. The “normal proximal contact area” is defined in the WREB manual as a contact that “resists the passage of lightly waxed floss.”26 The manual for the American Board of Dental Examiners (AMEX) dental examination (administered by the North East Regional Board of Dental Examiners [NERB]) states that “proximal contact is a critical part of the evaluation, and the candidate should be aware that the examiners will be checking the contact with floss . . . and proximal contacts must be visibly closed. . . . Proximal contacts that are not visibly closed or that do not permit the passage of floss are evaluated as Critical Deficiencies.”27 The AMEX manual mentions using “unwaxed dental floss” without specifying a particular brand.

The purpose of this study was to evaluate a single standardized interproximal contact with six brands of dental floss. In order to eliminate all possible physiologic variations in the natural dentition, a model with “ideal” contact points was used. Assessment of the contact area tightness (CAT) was performed by faculty members and students at Case Western Reserve University School of Dental Medicine. We hypothesized that there would be no difference between floss brands or between dental professionals and dental students in the evaluation of an “ideal” interproximal contact.

### Methods

For this study, a maxillary partial posterior teeth model with ideal interproximal contacts (P-Occlusal, Sao Paolo, Brazil) was stabilized on a NEY surveyor table (Dentsply International, York, PA, USA) (Figure 1, Figure 2). The contact was deemed “ideal” after three of the authors, each with more than ten years of clinical experience (ST, JJ, and SD), evaluated it with Dr. Ken’s Floss & Go dental floss; this brand was chosen for the baseline evaluation because it is specifically recommended in the WREB licensure exam manual. All three examiners scored the contact...
with a score of 2 on a five-point scale: no contact (0), light (1), ideal (2), tight (3), and too-tight (4) contact.

Thirty School of Dental Medicine faculty members and thirty dental students then evaluated a single interproximal contact between the second premolar and the first molar with six types of dental floss. The contact area between the second maxillary premolar and the first molar was chosen as an homage to G.V. Black, who used this site to illustrate the use of dental floss for evaluation of interproximal contacts (Figure 396 in G.V. Black’s book).20

Six brands of dental floss, identified through commercial catalogues available at our school, were evaluated: 1) Dr. Ken’s Floss & Go Single Use 18” Mint Waxed Floss (Dr. Fresh Inc., Buena Park, CA, USA); 2) G-U-M Eez-Thru Flossers (Sunstar Americas Inc., Chicago, IL, USA); 3) POH No Wax Classic Super Thin White Floss (Oral Health Products Inc., Tulsa, OK, USA); 4) Oral-B Satin Floss Mint (Oral-B Laboratories, Iowa City, IA, USA); 5) Crest Glide Original Floss (Procter & Gamble, Cincinnati, OH, USA); and 6) Johnson & Johnson Reach Unflavored Waxed Floss (Johnson & Johnson, New Brunswick, NJ, USA). These brands provide a representation of the available floss configurations available in the market, i.e., nylon or PFTE tape both in waxed and unwaxed configurations (Table 1).

Table 1. Characteristics of floss brands used in study

<table>
<thead>
<tr>
<th>Floss</th>
<th>Brand</th>
<th>Waxed/Unwaxed</th>
<th>Nylon/PFTE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Dr. Ken’s Floss &amp; Go’ Single Use 18” Mint Waxed Floss</td>
<td>Waxed</td>
<td>PFTE</td>
</tr>
<tr>
<td>B</td>
<td>G-U-M Eez-Thru Flossers</td>
<td>Unwaxed</td>
<td>PFTE</td>
</tr>
<tr>
<td>C</td>
<td>POH No Wax Classic Super Thin White Floss</td>
<td>Unwaxed</td>
<td>Nylon</td>
</tr>
<tr>
<td>D</td>
<td>Oral-B Satin Floss Mint</td>
<td>Waxed</td>
<td>Nylon</td>
</tr>
<tr>
<td>E</td>
<td>Crest Glide Original Floss</td>
<td>Waxed</td>
<td>PFTE</td>
</tr>
<tr>
<td>F</td>
<td>Johnson &amp; Johnson Reach Unflavored Waxed Floss</td>
<td>Waxed</td>
<td>Nylon</td>
</tr>
</tbody>
</table>

PFTE=polytetrafluoroethylene

*Brand recommended in the WREB candidate manual, recently rebranded as “Floss & Go.”

Results

The year of dental school graduation of the faculty members ranged from 1958 to 2003, with the mean graduation year being 1983 (SD=11.8 years). Thirty students participated in the experiment; twelve were third-year students, and eighteen were fourth-year students. The distribution of contact area tightness determination for each floss brand is shown in Table 2. Mauchly’s Test of Sphericity rejected the null assumption and pointed out that some significant differences existed within the results (Mauchly’s W=0.647, p=0.041).

Following the determination that the sphericity null assumption was violated, the results were analyzed with correction tests to determine if the differences were related to the evaluators (students versus faculty) or to the different brands of floss. The Huynh-Feldt correction test (F=2.106, p=0.067) showed that the students and faculty members were not different in the way they assessed contact area tightness with different flosses. The mean CAT scores by faculty and students for each type of floss are shown in Table 3.

The determination that there was no difference between students and faculty allowed combining the results obtained by all evaluators. Estimated CAT means and 95 percent confidence intervals for different floss brands were calculated (Table 4), followed by pairwise comparisons with the least significant
are required to self-assess their restorations before submitting their work for grading.

The other experimental variable was the floss brand. Our results confirm previous reports showing that different types of flosses have different gliding capacity and therefore may vary in the degree of force required to pass the contact area.

Dental floss manufacturers evolved from using silk before World War II to using nylon and more recently polytetrafluoroethylene (PFTE) tape, in both waxed and non-waxed configurations. The floss recommended by the WREB exam (Floss & Go; “A” in Tables 1-5) provides CAT results that differed from most other brands used in this study. The single brand that did not provide a statistically significant difference compared to Floss A was Johnson & Johnson Reach (“F” in Tables 1-5). It should be noted, however, that in comparing the results of Floss A with Floss F, the p-value was very close to the significance level (p=0.051). The two unwaxed floss brands tested (Gum Eez-Thru PFTE and POH nylon) showed statistically different results (Table 5), leading to the conclusion that the lack of definition in the AMEX manual regarding the recommended unwaxed floss brand may have clinical implications.

**Discussion**

This research project is unique because it is the first time experienced practitioners were compared to dental students regarding their ability to evaluate the contact area tightness (CAT) between teeth in a controlled experiment using different brands of dental floss. The rationale for using standardized models to eliminate in vivo variations of the proximal contact tightness has been previously explained and established. The results showing no difference between the faculty members’ and students’ evaluations are encouraging because the profile of dental licensure examiners is similar to that of faculty members; on the other hand, students who take the exam are required to self-assess their restorations before submitting their work for grading.

The other experimental variable was the floss brand. Our results confirm previous reports showing that different types of flosses have different gliding capacity and therefore may vary in the degree of force required to pass the contact area. Dental floss manufacturers evolved from using silk before World War II to using nylon and more recently polytetrafluoroethylene (PFTE) tape, in both waxed and non-waxed configurations. The floss recommended by the WREB exam (Floss & Go; “A” in Tables 1-5) provides CAT results that differed from most other brands used in this study. The single brand that did not provide a statistically significant difference compared to Floss A was Johnson & Johnson Reach (“F” in Tables 1-5). It should be noted, however, that in comparing the results of Floss A with Floss F, the p-value was very close to the significance level (p=0.051). The two unwaxed floss brands tested (Gum Eez-Thru PFTE and POH nylon) showed statistically different results (Table 5), leading to the conclusion that the lack of definition in the AMEX manual regarding the recommended unwaxed floss brand may have clinical implications.
Although these two U.S. licensure exams\textsuperscript{26,27} and the FDI World Dental Federation\textsuperscript{23} recommend using dental floss for evaluation of CAT, it seems that questions remain regarding the floss brand that should be used, the clinical significance of variability between brands, subjectivity of the evaluation, and the clinical significance of patient physiologic factors that induce CAT variability. Our results show that the difference in evaluation of contact points with different floss brands is not only statistically significant, but also potentially clinically meaningful. Out of sixty examiners, forty-five (75 percent) scored the tested contact as “ideal” when using Floss A (Dr. Ken’s Floss & Go), whereas only 28.3 percent scored it the same using Floss B (Gum Eez-Thru). Furthermore, despite Flosses B and C (POH) providing comparable results for the “ideal” score (28.3 percent and 30 percent, respectively), examiners using Floss B never scored the contact as “light,” whereas Floss C received this score in 70 percent of cases. Flosses A and F (Johnson & Johnson Reach) were not statistically different; both flosses are waxed but Floss A is PFTE whereas Floss F is nylon-based. Both brands A and E (Crest Glide) are waxed PFTE flosses and provided statistically significant differences; this difference, however, may not be clinically significant (Floss A scored 75 percent and Floss E scored 71.7 percent for “ideal” contact; Table 2). These examples illustrate that evaluation of contacts with different brands can have potential clinical implications such as determining that a contact is too light or excessively tight and therefore can lead in some cases to decision to replace the restoration.

Another question pertains to the clinical justification of using dental floss for evaluation of the contact area tightness of interproximal amalgam restorations. When one performs a Class II restoration, dental floss may be used to ensure the gingival margin is as clear of ledges as possible. However, if this is done too early in the procedure, there is a danger of damaging the marginal ridge or the contact point.\textsuperscript{32}

We recognize that only one specific contact area was checked in our study, and this may pose a limitation because it can be expected that the contact area morphology may impact the way the floss glides through.\textsuperscript{3} Another potential limitation is linked to the conditions of our experiment, i.e., using a model with teeth that do not exhibit mobility and in a dry environment. It was shown that saliva increases the force necessary for proximal contact passage of nylon floss because the floss increases in volume under wet conditions. Waxed nylon floss is less susceptible to this influence,\textsuperscript{33} so it can be expected that in a wet environment waxed dental floss and PFTE floss (for which there are no data regarding physical properties in dry vs. wet environments) may behave differently. The potential clinical significance of this limitation is not clear, and it is suggested as a topic for further research.

<table>
<thead>
<tr>
<th>Floss</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
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<td>0.046*</td>
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<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
<td></td>
<td>&lt;0.001*</td>
<td>&lt;0.001*</td>
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<tr>
<td>D</td>
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<td>&lt;0.001*</td>
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<td>0.001*</td>
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<tr>
<td>E</td>
<td></td>
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<tr>
<td>F</td>
<td></td>
<td></td>
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</table>

*Statistically significant difference (p<0.05)
what students have learned in their individual dental schools. It seems almost absurd that students who intend to participate in the WREB exam use a certain floss brand during their training, while other students in the same class who intend to take the AMEX exam will have to use a different brand. Providing more detailed information in these ways will aid faculty members in better aligning students’ education with what they will face on their licensure exams.

REFERENCES