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Comparison of marginal bleeding using a periodontal probe or an interdental brush as indicators of gingivitis

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Hofer D, Sahrmann P, Attin T, Schmidlin PR. Comparison of marginal bleeding using a periodontal probe or an interdental brush as indicators of gingivitis.

Abstract: *Aim:* To compare the use of interdental brushes with a periodontal probe in assessing marginal bleeding, in natural gingivitis. *Materials and methods:* Sixty-four consecutive volunteers presenting with gingival inflammation were recruited at their semi-annual recall appointments for this study. All had ≥50% papillary height and no pocketing that exceeded 4 mm. Contra-lateral quadrants (1 & 3 or 2 & 4) were randomly tested for bleeding with one pass-through with an interdental brush or with a periodontal probe inserted 2 mm into the gingival sulcus. The presence or absence of both bleeding and plaque was then recorded. Correlation coefficients were calculated for the interdental brushes and the periodontal probe, and the plaque and bleeding scores. *Results:* The periodontal probe and the interdental brushes showed mean average bleeding scores of 47.39% and 45.74% respectively. The correlation coefficient for the two methods was 0.73 ($P < 0.0001$). No correlation between plaque and bleeding was found. *Conclusions:* Interdental brushes can be considered a valid alternative to a periodontal probe in assessing marginal bleeding in gingivitis patients. An interdental brush, sized correctly for each interdental space, is easy to handle, atraumatic to the papillae and will allow gingivitis patients to monitor their own progress, while at the same time performing a beneficial oral hygiene procedure and removing any interdental plaque present.

Key words: bleeding index; gingivitis; interdental brush; periodontal probe

Introduction

In plaque-induced periodontal disease (1), the initial host response to the plaque challenge is overt gingival inflammation (2). This inflammation process often begins in the interdental areas (3, 4), with bleeding on probing as the first clinical sign of disease (5, 6). The measurement of gingival inflammation through use of a bleeding index may, however, not be entirely objective. A number of factors have been shown to influence the outcome of bleeding on probing, such as probe angulation, probe insertion depth, direction of probe movement and probing force (7, 8).

The Eastman Interdental Bleeding Index (EIBI), which employs a wood stick slid horizontally between the teeth, apical to the contact area, has been validated against the gold standard of bleeding on marginal probing (9, 10) and is free of the above mentioned probing weaknesses. While this gingival bleeding index has been used in previous studies

(11, 12), it may also, by virtue of the shape and rigidity of the wood sticks employed, have an inherent trauma potential (13). Therefore, this study was undertaken to evaluate the use of interdental brushes, which are a common and effective oral hygiene aid (11, 12, 14) regularly recommended and demonstrated for use in home care procedures, in assessing marginal bleeding (bleeding on interdental brushing – BOIB), and to validate this procedure against the use of a periodontal probe and the Bleeding on Marginal Probing Index (BOMP). It is our hypothesis that there will be no difference in the marginal bleeding measured by BOIB and the BOMP Index.

Materials and methods

Sixty-four consecutive volunteers who presented with gingival inflammation were recruited at their semi-annual recall appointments for this study. All were prescreened for the exclusion criteria of pocketing >4 mm and/or plaque and bleeding scores <30% at their last appointment; current papillary recession >50%, using the scale described by Jemt 1997 (15) (Fig. 1); and/or a smoking habit, if any, of >10 cigarettes per day. The goal and methodology of the study were explained, patient participation was requested and from those willing to participate, informed consent was obtained. The aims, methodology and rationale for this study had been previously submitted to and approved by the local ethics commission (EK 09/09).

Standard data collection, undertaken by one investigator (DJH), included review of medical histories, bleeding index, plaque index and intraoral photos. In this study, the clinic's standard bleeding on probing index (Gingiva-Index simplified) (16) was replaced with the BOIB and BOMP, in a split mouth test design. Contra-lateral quadrants (1 & 3 or 2 & 4) were randomly assigned to the test and control groups. Sites in the test group were subjected to one pass-through with a light interdental brush (Curaprox CPS Prime; Curaden AG, Kriens, Switzerland) (Fig. 2) placed buccally, just under the contact point and guided between the teeth with a jiggling motion, taking care not to exert force. If the brush met any resistance, a smaller brush was substituted and the insertion procedure was repeated. The control sites were tested with a periodontal probe (HH 12 DMS; Deppeler SA, Rolle, Switzerland) inserted 2 mm into the gingival sulcus, tipped to 60° and swiped horizontally, once, from the buccal and lingual/palatinal line angles to the middle col area. In both the test and control sites, bleeding was scored as either present or absent, for each interdental site within each quadrant, after 30 s (Fig. 3).

All teeth were then disclosed (paro®plak; Esro AG, Kilchberg, Switzerland) and the presence of plaque was graded using the O'Leary Plaque Index (17). Photos were taken with an intra-oral camera (PenScope; J. Morita MFG. Corp, Kyoto, Japan) to document papillary height and all sites were then probed to confirm that no patients with pocket depths exceeding 4 mm were included in the study. At this point, data collection for the study ended and all patients received their scheduled dental hygiene treatment.

The values for bleeding and plaque were analysed using StatView (Abacus Concepts, Inc., Berkley, CA, USA) for descriptive statistics, and correlation coefficients were calculated from the mean values for each individual quadrant as well as the contra-lateral quadrants together for the BOIB and BOMP. *P*-values <0.05 were accepted as statistically relevant.

COLOR

Fig. 1. Determination of papillary height was made visually, using the highest curvature of the gingival margin on adjacent teeth and the contact point of those teeth. A papilla deemed to cover ≥50% of this area met the inclusion criteria for this study.

Results

The demographics of our 64-person convenience sample showed a range of 29–78 years of age, with the average age being 46 years and the median age 44 years. The number of sites scored per quadrant ranged from 4 to 7, depending upon the number of teeth present and in direct contact with the adjacent tooth.

The correlation coefficient for bleeding on provocation in the test (brush) and control (probe) maxillary and mandibular sites combined was 0.73 ($P < 0.0001$). The individual quadrants had correlation coefficients of 0.72 ($P < 0.0001$) for the maxillary and mandibular test quadrants and 0.53 ($P < 0.0001$) for the maxillary and mandibular control quadrants.

The correlation coefficient for plaque accumulation in the combined sites was 0.92 ($P < 0.0001$). The correlation between plaque and bleeding was, however, only 0.23 both in the BOIB combined arch sites ($P > 0.05$) and in the BOMP combined arch sites ($P > 0.05$). The results are summarized in Tables 1 and 2.

Discussion

The goal of this study was to evaluate the use of an interdental brush for assessing marginal bleeding and correlate the resultant bleeding on provocation to the bleeding provoked by the use of a periodontal probe when performing the Bleeding on Marginal Probing Index. The bleeding provoked by both

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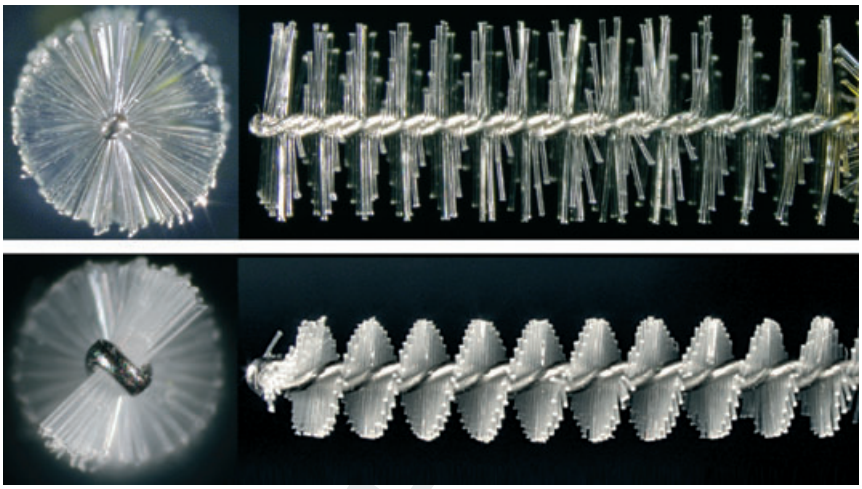

Fig. 2. Upper row: a 'light' interdental brush (CPS prime 109, wire diameter 0.9 mm, outer brush diameter 4.0 mm) used for the bleeding on interdental brushing (BOIB) assessment. Lower row: a standard interdental brush (CPS regular 110, wire diameter 1.0 mm, outer brush diameter 2.2 mm). Note the denser, more rigid filaments.

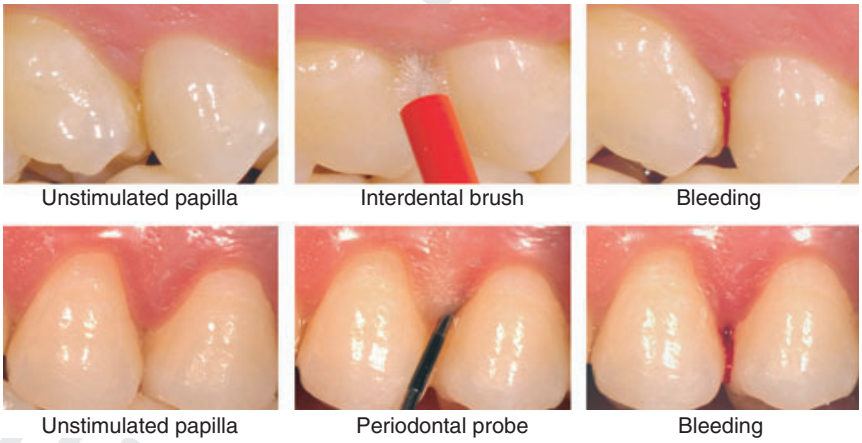

Fig. 3. Upper row: bleeding on interdental brushing (BOIB). Lower row: bleeding on marginal probing (BOMP).

Table 1. **Mean (±1SD) plaque and bleeding scores, assessed in a split-mouth design, and their correlation coefficients**

	Plaque Maxilla + mandible	Bleeding Maxilla + mandible	Correlation coefficient
BOMP sites	88.1% (±21.3%)	47.5% (±24.1%)	NS
BOIB sites	89.4% (±17.7%)	45.8% (±31.1%)	NS
Correlation coefficient	0.92 ($P < 0.0001$)	0.73 ($P < 0.0001$)	

BOMP, bleeding on marginal probing; BOIB, bleeding on interdental brushing.

Table 2. **Mean (±1SD) bleeding scores assessed by arch and their inter- and intra-method correlation coefficients**

	Bleeding Maxilla	Bleeding Mandible	Correlation coefficient
BOMP sites	51.1% (±24.9%)	44.8% (±28.0%)	0.53 ($P < 0.0001$)
BOIB sites	47.5% (±35.2%)	44.8% (±32.6%)	0.72 ($P < 0.0001$)
Correlation coefficient	0.54 ($P < 0.0001$)	0.66 ($P < 0.0001$)	

BOMP, bleeding on marginal probing; BOIB, bleeding on interdental brushing.

methods was also examined for any correlation to the plaque accumulations present.

The overall correlation of 0.73 between bleeding provoked by a periodontal probe exerting lateral pressure on the inner sulcus wall and an interdental brush depressing the buccal and lingual papillae was statistically significant. This correlation was even stronger than the results presented by Barendregt *et al.* (10), who calculated a correlation coefficient of 0.62 when they compared bleeding using a wood stick, as originally described for the EIBI, with a periodontal probe in the BOMP.

The reasons that an interdental brush provided a higher degree of correlation to a periodontal probe than a wood stick can only be speculated upon, given the limitations of this study. However, it seems reasonable that an interdental brush, chosen correctly, will provide a greater surface area contact, moving against the inner, non-keratinized col epithelium as well as provide a broader depression of the papillary tissues.

In this study, the interdental brushes selected for use were less thickly wound than most types found available for home use. The central wire was also thinner than standard interdental brush wires, allowing atraumatic insertion in interdental

spaces as small as 0.6 mm. Five different size brushes, with filament diameters of up to 5 mm, were available for selection, according to the size of the interproximal spaces. Each interdental space was filled, using the largest possible diameter brush that slid without resistance between the teeth, and the papillary tissues were provoked for bleeding as delicately as possible.

Anatomical differences between maxillary and mandibular teeth, especially molars, may account for the correlation differences between the bleeding observed in the upper and lower arches using interdental brushes or a periodontal probe. The inter-method correlation coefficient for interdental brushes was 0.72, while the periodontal probe showed a correlation of 0.54. While it could be assumed that brush size selection, without use of a guide or pretest, would be difficult, the results support our use of a relatively non-invasive technique of jiggling to allow the brush to find its own way between the teeth. Where the interdental space was too small for the brush size selected to enter, no bleeding was elicited and a smaller size brush could immediately be substituted. The intra-method correlation coefficient pro arch was not as great as the combined results, which was probably a result of statistical sensitivity, as well as the anatomical factors mentioned above.

The high degree of correlation between plaque observed in the test and control sites shows that its accumulation was evenly distributed throughout the dentition. The mean average plaque index values of 88.05% and 89.40% show that plaque was present on almost all surfaces scored. As known gingivitis patients were filtered from the clinic's recall population for this study, these high plaque index scores were no surprise. Bleeding, on the other hand, was observed in <50% of all sites and the correlation coefficient between plaque and bleeding was a low 0.23.

That the plaque accumulation and the bleeding on probing did not correlate well are in accordance with earlier studies (18–20) showing that visually inflamed sites do not necessarily bleed on provocation. Furthermore, the age of the study population (mean age: 45 years, range: 26–78 years) and the requirement that at least 50% of the papillary height be present for inclusion in the study suggest that this population is not susceptible to periodontal breakdown, even in the presence of plaque. However, an innate resistance, as displayed by our narrowly defined test population, is not characteristic of plaque-induced disease progression found among the general population.

Epidemiological studies show that in Europe 13–54% of the 35–44-year-old population has shallow periodontal pocketing (3.5–5.5 mm) (21). In the USA, similar findings were reported, whereby about 50% of the 55–64-year-old population have clinical attachment loss of ≥4 mm (22). While gingivitis may be present without further progression to periodontitis, plaque-induced periodontitis appears to always be preceded by gingivitis (23, 24). Furthermore, in studies examining early-onset periodontitis, adolescents and young adults who displayed overt gingival inflammation also had a higher propensity for periodontal attachment loss (25–27). As clinical symptoms do not allow for differentiation between patients with gingival inflammation that will progress further and those that will remain stable (28), it remains propitious to identify and treat gingivitis in all patients at its earliest stages. Therefore, a simple yet reliable screening index, which can be implemented in conjunction with both in-office oral hygiene instruction (demonstration of atraumatic brush insertion/usage and concurrent recording of BOIB) and home care procedures (self-monitoring of progress), would be a valuable tool for patients and their dental caregivers alike.

Conclusions

The correlation between the BOMP and BOIB shows that a marginal bleeding assessment performed with interdental brushes can be considered a valid method for assessing gingivitis. The advantages of using an interdental brush to test for bleeding include atraumatic manipulation of the papillae, ease of application, integration into existing oral hygiene instruction and motivating patients to monitor their own progress at home, while at the same time performing a beneficial oral hygiene procedure and removing any interdental plaque that may be present.

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References

1 Armitage GC. Development of a classification system for periodontal diseases and conditions. *Ann Periodontol* 1999; **4:** 1–6.

2 Kinane DF, Berglundh T, Lindhe J. ???????????. In: Lindhe J, Karring T, Lang KP, eds. *Clinical Periodontology and Implant Dentistry*, 4th edn. Copenhagen, Blackwell Munksgaard, 2003, pp. ???–???.

3 Hugoson A, Koch G. Oral health in 1000 individuals aged 3–70 years in the community of Jonkoping, Sweden. A review. *Swed Dent J* 1979; **3:** 69–87.

4 Loe H, Morrison E. Periodontal health and disease in young people: screening for priority care. *Int Dent J* 1986; **36:** 162–167.

5 Muhlemann HR, Son S. Gingival sulcus bleeding-a leading symptom in initial gingivitis. *Helv Odontol Acta* 1971; **15:** 107–113.

6 Lenox JA, Kopczyk RA. A clinical system for scoring a patient's oral hygiene performance. *J Am Dent Assoc* 1973; **86:** 849–852.

7 Van der Weijden GA, Timmerman MF, Nijboer A, Reijerse E, Van der Velden U. Comparison of different approaches to assess bleeding on probing as indicators of gingivitis. *J Clin Periodontol* 1994; **21:** 589–594.

8 Lang NP, Nyman S, Senn C, Joss A. Bleeding on probing as it relates to probing pressure and gingival health. *J Clin Periodontol* 1991; **18:** 257–261.

9 Caton J, Polson A, Bouwsma O, Blieden T, Frantz B, Espeland M. Associations between bleeding and visual signs of interdental gingival inflammation. *J Periodontol* 1988; **59:** 722–727.

10 Barendregt DS, Timmerman MF, van der Velden U, van der Weijden GA. Comparison of the bleeding on marginal probing index

and the Eastman interdental bleeding index as indicators of gingivitis. *J Clin Periodontol* 2002; **29:** 195–200.

11 Yost KG, Mallatt ME, Liebman J. Interproximal gingivitis and plaque reduction by four interdental products. *J Clin Dent* 2006; **17:** 79–83.

12 Jackson MA, Kellett M, Worthington HV, Clerehugh V. Comparison of interdental cleaning methods: a randomized controlled trial. *J Periodontol* 2006; **77:** 1421–1429.

13 Greene PR, Jackson M. ????????????. In: Ireland R, ed. *Clinical Textbook of Dental Hygiene and Therapy*. Copenhagen, Blackwell Munksgaard, 2006, pp. 119–Xxxx.

14 Slot DE, Dorfer CE, Van der Weijden GA. The efficacy of interdental brushes on plaque and parameters of periodontal inflammation: a systematic review. *Int J Dent Hyg* 2008; **6:** 253–264.

15 Jemt T. Regeneration of gingival papillae after single-implant treatment. *Int J Periodontics Restorative Dent* 1997; **17:** 326–333.

16 Caton JG, Polson AM. The interdental bleeding index: a simplified procedure for monitoring gingival health. *Compend Contin Educ Dent* 1985; **6:** 88, 90–92.

17 O'Leary TJ, Drake RB, Naylor JE. The plaque control record. *J Periodontol* 1972; **43:** 38.

18 Greenstein G. The role of bleeding upon probing in the diagnosis of periodontal disease. A literature review. *J Periodontol* 1984; **55:** 684–688.

19 Muller HP, Heinecke A. The influence of gingival dimensions on bleeding upon probing in young adults with plaque-induced gingivitis. *Clin Oral Investig* 2002; **6:** 69–74.

20 Trombelli L, Farina R, Manfrini R, Tatakis DN. Modulation of clinical expression of plaque-induced gingivitis: effect of incisor crown form. *J Dent Res* 2004; **83:** 728–731.

21 Sheiham A, Netuveli GS. Periodontal diseases in Europe. *Periodontol 2000* 2002; **29:** 104–121.

22 Burt B. Position paper: epidemiology of periodontal diseases. *J Periodontol* 2005; **76:** 1406–1419.

23 Albandar JM, Rams TE. Global epidemiology of periodontal diseases: an overview. *Periodontol 2000* 2002; **29:** 7–10.

24 Topazian RGGMH, Hupp JR. *Oral and Maxillofacial Infections*. Philadelphia, PA: W.B. Saunders Company; 2002: 129.

25 Albandar JM, Kingman A, Brown LJ, Loe H. Gingival inflammation and subgingival calculus as determinants of disease progression in early-onset periodontitis. *J Clin Periodontol* 1998; **25:** 231–237.

26 Tanner AC, Kent RJ, Van Dyke T, Sonis ST, Murray LA. Clinical and other risk indicators for early periodontitis in adults. *J Periodontol* 2005; **76:** 573–581.

27 Tanner AC, Paster BJ, Lu SC *et al*. Subgingival and tongue microbiota during early periodontitis. *J Dent Res* 2006; **85:** 318–323.

28 Armitage GC. Periodontal diseases: diagnosis. *Ann Periodontol* 1996; **1:** 37–215.

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