Establishment of a New Marginal Plaque Index With High Sensitivity for Changes in Oral Hygiene

Renate Deinzer,* Stephan Jahns,* and Daniela Harnacke*

**Background:** Although several plaque indices exist, they rarely assess in detail the plaque adjacent to the gingival margin, an area most important for periodontal health. This study aims to develop a new marginal plaque index (MPI) and to assess its validity and treatment sensitivity compared to the internationally accepted Turesky modification of the Quigley and Hein Index (TQHI).

**Methods:** Data from two studies with n = 64 and n = 67 participants, respectively, are reported here. Convergence of MPI with TQHI and concurrent and predictive validity with papillary bleeding index were assessed, as was treatment sensitivity to a treatment of proximal hygiene (study 1) or toothbrushing (study 2), respectively.

**Results:** Convergent validity with TQHI is very good. Concurrent and predictive validity parameters of the MPI are similar to the TQHI. The treatment sensitivity of MPI exceeds TQHI by far. This results in a reduction by >70% of the sample size needed to discover significant treatment effects. As expected, the largest treatment sensitivity was observed for proximal MPI measures in study 1, whereas study 2 showed largest effects for cervical measures.

**Conclusions:** MPI appears to be a valid plaque-scoring system that assesses plaque at the gingival margin. It responds with high sensitivity to treatments aimed at plaque reduction at the gingival margin. Its treatment sensitivity and capacity to differentiate between proximal and cervical plaque make it a promising tool for periodontal research.

**KEY WORDS**
Dental plaque; dental plaque index; gingivitis; oral health; oral hygiene; reproducibility of results.

Several plaque indices (PIs) are available to assess oral hygiene and the efficacy of clinical trials to improve hygiene skills (Table 1). Some PIs rely on examiner ordinal ratings of plaque extension, such as the Turesky modification of the Quigley and Hein index (TQHI) or the Silness and Löe index. Others, such as the axial and the proximal plaque extension index, use a ratio-scaled approach by measuring the extension of plaque with a linear scale. Still others quantify plaque extension by assessing its weight or by image analysis of pictures of disclosed plaque. Additional indices confine scoring to the registration of the presence or absence of plaque in prespecified areas of the tooth. One potential disadvantage of TQHI is that it does not allow for a distinctive analysis of plaque deposits adjacent to...
the gingival margin. However, it is precisely this area that is of high clinical relevance, especially with respect to gingivitis and periodontitis. Therefore, it might even suffice to confine plaque assessment to the gingival margin when gingivitis and/or periodontitis are the main focus. Furthermore, because it is difficult to remove plaque at the gingival margin without removing it more coronally as well, marginal plaque might be a good and clinically relevant indicator for overall oral hygiene. Two indices already allow for a more differentiated analysis of plaque deposits adjacent to the gingival margin: 1) the O’Leary plaque control record;12 and 2) its advancement, the plaque assessment scoring system.10 These indices assess plaque at four sections per tooth: 1) proximal distal, 2) proximal mesial, 3) vestibular, and 4) oral. Unfortunately, the borders of these four sections are not clearly defined. Furthermore, to the best of the authors’ knowledge, none of these indices was validated with respect to international standards, such as the Silness and Löe3 index or the TQHI. Because the indices do not differentiate between proximal plaque deposits situated orally or vestibularly, it was decided to develop a new index.

The newly developed marginal plaque index (MPI) divides the dento-gingival junction of each tooth surface (i.e., oral and vestibular, respectively) into four easily localized sections. This index differentiates between plaque deposits situated more proximally or more cervically. According to the suggestion of Galgut,20 assessment was confined to the registration of the presence or absence of plaque, which is recorded for each of eight sections per tooth. The present study aims to assess the validity of this new index and to compare its treatment sensitivity to TQHI as an internationally well-accepted and validated standard. This study also aims to examine whether this index differentially responds to different treatment focuses, i.e., interproximal hygiene versus toothbrushing, which would further enhance its value for interventional research.

## Materials and Methods

### Ethics

The study protocols were approved by the local ethics committee (Ethics Committee of the Medical Faculty of the University of Giessen, Giessen, Germany) and were found to conform to the guidelines of the Declaration of Helsinki. All participants gave their informed written consent to participate.

### Participants and Procedures

Data from two studies are reported here.21,22 Study 1 analyzed, from May 2013 to November 2013, a convenient sample of n = 64 (32 males and 32 females, aged 18 to 66 years; mean ± SD age: 34.49 ± 11.91 years) non-smoking dental patients of a private practice with a periodontal screening index21 ranging from 1 to 3 (median of 2). Participants were asked to brush their teeth. No instruction was given regarding brushing technique or thoroughness. Afterwards, proximal sites were cleaned by a dental hygienist (unidentified) by means of dental floss and/or interproximal brushes in two opposite quadrants, whereas the other two were left untreated. The decision about which quadrants to treat by the dental hygienist was made randomly (lot drawn for each participant). An examiner (SJ), masked to the condition of the quadrants and calibrated previously (see below), assessed the TQHI and MPI (see below).

Study 2 was an experimental study mainly aimed at comparing the efficacy of training of different
brushing techniques on participants’ oral hygiene skills. The study took place from November 2009 to September 2010 in the dental examination rooms of the Institute of Medical Psychology, Justus Liebig University, Giessen, Germany. This dataset allows for analyses similar to those of study 1 and was used to extend the data basis for the evaluation of the MPI. Study details were reported previously.\(^2\) Briefly, n = 67 students (not studying dentistry or medicine; 15 males and 52 females, aged 20 to 29 years; mean age: 23.3 years), showing imperfect oral hygiene (inclusion criterion: ≥10 sites showing plaque deposits and/or gingival bleeding), were randomly assigned either to a control group that received training about the basics of toothbrushing only (i.e., how to floss, sites to be cleaned, systematics of toothbrushing, and pressure while brushing) or one of two intervention groups additionally trained in the modified Bass or Fones technique, respectively. Data were assessed 2 weeks before the intervention and 6, 12, and 28 weeks later by four calibrated examiners (SJ, doctoral students, Simona Mitter, Marc Lehner, and Katrin Reinhardt, Institute for Medical Psychology, University of Giessen, Giessen, Germany). Each examiner analyzed only a subsample of participants at each measurement point. This prevented data from being biased by the specific assessment skills and characteristics of an individual examiner.

**Clinical Measures**

All examiners were calibrated with individuals other than the study participants until unanimous agreement for ≥90% of measures and mismatches of no more than one score unit were observed.

Gingivitis was assessed by means of a modification of the papillary bleeding index (PBI) of Saxer and Mühlmann:\(^2\) a World Health Organization probe was moved gently along the gingival crevice of the respective papilla at oral and vestibular surfaces, and the subsequent bleeding responses were rated as follows: 1) 0 = no bleeding; 2) 1 = single bleeding point; 3) 2 = narrow line of blood; 4) 3 = interdental triangle filled with blood; and 5) 4 = profuse bleeding.

Plaque deposits were disclosed by a disclosure solution\(^1\) that stains old plaque deposits blue and fresh deposits pink. Stained deposits were assessed by TQHI as the internationally well-known and accepted standard and MPI as a new measure to assess oral hygiene. In study 1, all staining was assessed after proximal hygiene. In study 2, old plaque (i.e., plaque stained blue) was assessed before toothbrushing as an indicator of habitual oral hygiene, and all staining was assessed immediately after participants were instructed to eliminate all plaque deposits to the best of their ability by means of toothbrushing and dental floss. TQHI assesses plaque in six grades at oral and vestibular surfaces, respectively: 1) 0 = no plaque; 2) 1 = separate flecks of plaque at the cervical margin of the tooth; 3) 2 = a thin continuous band of plaque, up to 1 mm, at the cervical margin of the tooth; 4) 3 = a band of plaque wider than 1 mm but covering less than one-third of the crown of the tooth; 5) 4 = plaque covering at least one-third but less than two-thirds of the crown of the tooth; and 6) 5 = plaque covering two-thirds or more of the crown of the tooth.

The MPI assesses the presence (score 1) or absence (score 0) of plaque within eight equal sections of a tooth (four at the oral and four at the vestibular gingival margin, respectively) (Fig. 1).

**Statistical Data Analyses**

A standard statistic program\(^\dagger\) is used for all computations.

Outliers (more than three standard deviations from the mean) were excluded from analyses to avoid distortions of statistics by single outlying values. The normal distribution was tested using Kolmogorov-Smirnov goodness-of-fit tests. Pearson and Spearman correlations were computed. Spearman correlations refer to the rank order of the variables and, thereby, control for artifacts induced by distortions of the distribution not detected by the Kolmogorov-Smirnov goodness-of-fit test.

**Convergent Validity**

The most important criterion for the quality of a measurement method is its validity. Several methods exist to prove the validity of a method. The most common, also often used in research for PIs, is to assess its convergent validity, i.e., its correlation with another index that is already well established and considered to be a standard. TQHI is considered to be such a measure.\(^4,5,8,9,15,18\) The convergent validity of the MPI was assessed with TQHI in study 1 for quadrants without dental flossing and in study 2 for baseline measures.

**Criterion Validity: Concurrent and Predictive Validity**

Another measure to estimate the validity of a parameter is to prove whether it shares variance (i.e., correlates) with an external criterion that is expected to be related to that parameter. This reflects the so-called criterion validity of the parameter. Two aspects of criterion validity of a parameter can be assessed: 1) its concurrent validity, i.e., the correlation of the parameter with the criterion, both assessed at the same point in time; and 2) its predictive validity, i.e., the correlation of the parameter assessed today with the criterion assessed in the future. Dental plaque is

\(^1\) Mira-2-Ton solution, Hager & Werken, Duisburg, Germany.

\(^\dagger\) SPSS v.20, IBM, Chicago, IL.
known to cause gingivitis. One method to prove the criterion validity of PIs is, thus, to assess its criterion validity by means of a parameter assessing gingivitis. This also provides insight into the clinical significance of the indices assessed. The concurrent (study 1 and study 2) and predictive validity (study 2 only) of MPI and TQHI with PBI was assessed. To assess the concurrent validity, the correlations of plaque and bleeding measures were computed for quadrants without dental floss in study 1 and for baseline hygiene values in study 2. For the predictive validity, the correlation of hygiene measures assessed in the control group of study 2 was computed 12 weeks after treatment, and papillary bleeding was assessed 28 weeks afterward.

**Treatment Effects**

Another criterion characterizing the utility of a parameter for scientific research and for practice is its treatment sensitivity. Thus, treatment effects have to be compared. Furthermore, when the MPI was modeled, the present study aimed to develop an index that allows differentiation between treatment effects in proximal and cervical sections of the teeth. It was expected that interproximal hygiene as performed in study 1 would show greater effect sizes in MPI proximal sections than in cervical sections. In contrast, greater treatment effects were expected for cervical sections in study 2, in which participants differed with respect to training of brushing techniques but not in interproximal hygiene.

In study 1, the effect sizes of the treatment effects (flossing versus no flossing) for all parameters were compared. Because study 1 used a within-design individual treatment, effects could be calculated by subtracting the values observed in quadrants with proximal hygiene from those observed in quadrants without proximal hygiene. To standardize this measure, it was divided by the standard deviation of all participants in the quadrants without proximal hygiene. In doing so, the measures were normalized for the treatment effect that now uses the standard deviation of the untreated condition as the unit of analysis for all parameters. This allows for an immediate statistical comparison between the treatment effects. The metrics correspond to Cohen’s $d$. Cohen’s $d$ is a well-established standardized measure of effect size of group comparisons. Values of $d = 0.20$, $d = 0.50$, and $d = 0.80$ are considered to represent small, medium, and large effect sizes, respectively. As suggested for comparisons between a treated and an untreated condition, the standard deviation of the untreated condition is taken as the reference here. $t$-tests for dependent variables were computed to compare the treatment effects as they were measured by TQHI, MPI all sections, MPI proximal sections, and MPI cervical sections. Further, $t$-tests for the immediate comparisons of quadrants with and without proximal hygiene were computed.

In study 2, the previous analyses revealed the greatest treatment effects on gingivitis after 12 weeks, and within this parameter, the greatest group difference between the Fones and Bass groups (Fones improved more than Bass, see reference 22). This point in time and these two groups were thus chosen to analyze the effect sizes of treatment effects for oral hygiene skills. The improvement of hygiene parameters was computed by subtracting 12-week measures from baseline measures. The groups were compared by $t$ tests for independent variables and Cohen’s $d$s were computed for these comparisons. The unit of analysis was the pooled standard deviation of both groups, as recommended for comparisons between different treatments. The $d$ values and the $t$ statistics of group comparisons are reported here. Unfortunately, no statistics are available allowing for an inferential comparison of effect sizes assessed within the same sample but referring to a comparison of independent treatment groups within that same sample.

To further delineate the practical meaning of the differences in effect sizes observed in the present
study, these effect sizes were used for sample-size calculations as one would do in planning additional studies analyzing similar treatments. α- and β-error probability was set at 0.05 (i.e., test power of 95%), and a statistical program was used for these computations.

RESULTS

Outlying values were observed for one individual with outlying values in both PBI measures in study 1 and one participant of the Fones group in study 2 at the 12-week measurement point with respect to the MPI in all sections and cervical sections before oral hygiene. After exclusion of outliers, no significant deviations from the normal distribution assumption were observed for any of the analyzed variables.

Table 2 shows the convergent validity of MPI with TQHI measures. Significant convergence was found for all measures in both studies. The lowest values were observed when plaque was assessed after thorough oral hygiene in study 2. Measures for the concurrent validity of plaque and PBI measures are presented in Table 3. Significant concurrence was found in both studies for both MPI and TQHI measures. Predictive validity for the PBI as assessed in a subgroup of n = 19 participants from study 2 is shown in Table 4. Both MPI and TQHI parameters showed significant predictive validity for PBI measures assessed 16 weeks later.

Table 5 depicts treatment effects as assessed in studies 1 and 2 by the different plaque measures. In study 1, effect sizes of MPI all sections and MPI proximal sections differed significantly between each other (P < 0.001) and compared to TQHI or MPI cervical sections (all P < 0.001). Effect sizes for TQHI and MPI cervical sections did not differ (P = 0.607). In study 1, the largest treatment effects were observed for MPI proximal, whereas in study 2, the largest effects were observed for MPI cervical. Table 5 also depicts the results of sample-size calculations based on the respective effect sizes observed in the present study. It can be seen that, in both studies, the smallest sample sizes are required for MPI measures.

DISCUSSION

The present study aims to analyze the validity of the MPI and to compare its treatment sensitivity to TQHI as a widely accepted and already validated standard.

The convergent validity of the MPI measures with TQHI is excellent under conditions of no treatment (study 2, before oral hygiene) or superficial pretreatment (study 1, brushing without any additional instruction). After more intensive pretreatment (study 2, instruction to accomplish oral hygiene to the best of one’s ability to remove all plaque), convergence between TQHI and MPI measures declines, although values remain satisfactory (Table 2). The most plausible explanation for the decrease in convergence is the different treatment sensitivity of the parameters, discussed below.

Considering the fact that plaque measures and bleeding indices assess two different but related factors, concurrent validity of both the TQHI and MPI measures with PBI is fairly good (Table 3). Differences between the concurrent validity of TQHI and MPI are small. However, only non-significant correlations are observed when plaque parameters are assessed immediately after thorough oral hygiene. The plaque measures assessed after thorough oral hygiene represent the patient’s plaque-removing skills. Assessment before oral hygiene and presumably also assessment after brushing the teeth without any additional instruction is a better representative of habitual oral hygiene. Papillary bleeding represents consequences of plaque persisting for several days to weeks. Within a retrospective analysis like the present one, it would be expected for PBI values to correlate better with indicators of habitual oral hygiene than with oral hygiene skills.

Regarding the predictive validity of the plaque measures for papillary bleeding, only data of a subsample of n = 19 individuals from study 2 were available. These data indicate a predictive validity even better than the concurrent validity (Table 4). No meaningful differences between the TQHI and MPI measures can be seen. When comparing the differences between predictive and concurrent validity, one
should take into account the differing pretreatments. The concurrent validity was assessed before any experimental pretreatment, whereas the predictive validity was assessed within an ongoing study after participants had received professional tooth cleaning and training of the basics of toothbrushing. Indeed, the pretreatment might be regarded as a kind of standardization. Before professional tooth cleaning, other factors (e.g., last visit to a dentist, hygiene habits, eating habits) might have a greater effect on the present measures than after professional removal of all plaque deposits and basal oral hygiene instructions. Thus, the pretreatment presumably reduced unsystematic variance and allowed for higher correlations.

With regard to validity values, MPI is comparable to TQHI as an international standard. Its convergent validity with TQHI is excellent under conditions with minimal or no intervention. It decreases with more advanced treatment. This might be attributable to the differential treatment sensitivities of TQHI and MPI measures.

Indeed, the data presented in Table 5 show remarkable differences in the treatment sensitivity of both measures. The treatment sensitivity of MPI values exceeds considerably that of TQHI values, after both an intervention aiming to reduce proximal plaque (study 1) and an intervention aiming to improve brushing skills (study 2). Although no more than medium effect sizes are observed for TQHI parameters, large effect sizes are seen within the different MPI measures. When planning a study, this would result in a reduction of the sample size needed (to receive significant results with a test power of 95%) by >70% (Table 5). Furthermore, as expected, the different MPI parameters respond differently to different study aims: maximum effect sizes are observed for proximal sites when interproximal hygiene is the focus (study 1), whereas cervical measures yield the largest effect

Table 3.
Concurrent Validity: Correlation of Plaque Measures With Mean Papillary Bleeding Measured at the Same Time

<table>
<thead>
<tr>
<th>Study and Procedure</th>
<th>MPI Sections</th>
<th>TQHI</th>
<th>All</th>
<th>Proximal</th>
<th>Cervical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study 1 (n = 63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All staining, untreated quadrants</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson r</td>
<td>0.275*</td>
<td>0.167</td>
<td>0.066</td>
<td>0.251*</td>
<td></td>
</tr>
<tr>
<td>Spearman p</td>
<td>0.342*</td>
<td>0.341*</td>
<td>0.176</td>
<td>0.398*</td>
<td></td>
</tr>
<tr>
<td>Study 2 (n = 67)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue staining before hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson r</td>
<td>0.322*</td>
<td>0.303*</td>
<td>0.236</td>
<td>0.310*</td>
<td></td>
</tr>
<tr>
<td>Spearman p</td>
<td>0.272*</td>
<td>0.313*</td>
<td>0.275*</td>
<td>0.301*</td>
<td></td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson r</td>
<td>0.101</td>
<td>0.176</td>
<td>0.094</td>
<td>0.209</td>
<td></td>
</tr>
<tr>
<td>Spearman p</td>
<td>0.161</td>
<td>0.156</td>
<td>0.080</td>
<td>0.174</td>
<td></td>
</tr>
</tbody>
</table>

* P<0.05. For additional details, see Materials and Methods.

Table 4.
Predictive Validity in 19 Controls in Study 2: Correlations of Plaque Measures Assessed in Week 12 With Papillary Bleeding Assessed in Week 28 After Treatment

<table>
<thead>
<tr>
<th>Procedure</th>
<th>MPI Sections</th>
<th>TQHI</th>
<th>All</th>
<th>Proximal</th>
<th>Cervical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue staining before hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson r</td>
<td>0.577*</td>
<td>0.528*</td>
<td>0.432</td>
<td>0.577*</td>
<td></td>
</tr>
<tr>
<td>Spearman p</td>
<td>0.635*</td>
<td>0.688*</td>
<td>0.574*</td>
<td>0.635*</td>
<td></td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pearson r</td>
<td>0.665*</td>
<td>0.614*</td>
<td>0.560*</td>
<td>0.635*</td>
<td></td>
</tr>
<tr>
<td>Spearman p</td>
<td>0.674*</td>
<td>0.623*</td>
<td>0.549*</td>
<td>0.742*</td>
<td></td>
</tr>
</tbody>
</table>

* P<0.05. For additional details, see Materials and Methods.
Table 5.
Treatment Effects as Measured by the TQHI and MPI Parameters

<table>
<thead>
<tr>
<th>Study, PI, and Procedure</th>
<th>Proximal Hygiene</th>
<th>No Proximal Hygiene</th>
<th>Difference: Baseline to 12 Weeks</th>
<th>Sample Size Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fones (n = 19)</td>
<td>Bass (n = 18)</td>
<td>t</td>
<td>p</td>
</tr>
<tr>
<td>Study 1 (n = 63)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All staining</td>
<td>TQHI</td>
<td>1.42 ± 0.40</td>
<td>1.66 ± 0.39</td>
<td>5.23</td>
</tr>
<tr>
<td>All staining</td>
<td>MPI all</td>
<td>43.87 ± 13.40</td>
<td>66.21 ± 17.37</td>
<td>8.91</td>
</tr>
<tr>
<td>All staining</td>
<td>MPI proximal</td>
<td>36.07 ± 15.66</td>
<td>68.86 ± 18.57</td>
<td>10.43</td>
</tr>
<tr>
<td>All staining</td>
<td>MPI cervical</td>
<td>51.67 ± 14.97</td>
<td>63.57 ± 18.13</td>
<td>5.30</td>
</tr>
<tr>
<td>Study 2 (n = 37)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blue staining before hygiene</td>
<td>TQHI</td>
<td>0.49 ± 0.33</td>
<td>0.43 ± 0.39</td>
<td>0.52</td>
</tr>
<tr>
<td>Blue staining before hygiene</td>
<td>MPI all</td>
<td>13.75 ± 7.61</td>
<td>10.47 ± 9.55</td>
<td>1.14</td>
</tr>
<tr>
<td>Blue staining before hygiene</td>
<td>MPI proximal</td>
<td>14.56 ± 10.71</td>
<td>13.00 ± 12.04</td>
<td>0.42</td>
</tr>
<tr>
<td>Blue staining before hygiene</td>
<td>MPI cervical</td>
<td>12.04 ± 7.81</td>
<td>7.94 ± 9.40</td>
<td>1.42</td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td>TQHI</td>
<td>0.88 ± 0.57</td>
<td>0.57 ± 0.56</td>
<td>1.68</td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td>MPI all</td>
<td>15.83 ± 14.99</td>
<td>17.5 ± 12.75</td>
<td>3.08</td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td>MPI proximal</td>
<td>21.04 ± 16.11</td>
<td>8.65 ± 16.25</td>
<td>2.33</td>
</tr>
<tr>
<td>All staining after thorough hygiene</td>
<td>MPI cervical</td>
<td>10.62 ± 16.02</td>
<td>-5.16 ± 10.18</td>
<td>3.55</td>
</tr>
</tbody>
</table>

Data are presented as mean ± SD.
* P < 0.05, significant treatment effects, t test for dependent measures (study 1) and independent measures (study 2); d based on the standard deviation of the untreated quadrants (study 1) and the pooled standard deviation (study 2). For additional details, see Materials and Methods.
image analyses are usually confined to vestibular surfaces, whereas weight analyses remove plaque, which may not be useful in research settings observing individuals during a longer period of time or in settings with a prepost assessment within one appointment. Future studies might prove the convergence of MPI with more sophisticated quantitative methods of plaque assessment. Considering the criterion validity of the MPI demonstrated in the present study, there is already good evidence of its clinical significance. Another potential criticism is the fact that cervical plaque measures have a somewhat larger validity than proximal measures, at least with respect to TQHI and to papillary bleeding. In the German population, daily flossing or other measures of interproximal hygiene are not standard, but daily brushing is performed by the vast majority.28,29 Proximal hygiene appears to be performed because of the subjective need to free interproximal spaces from leftovers of a meal rather than on a regular basis to improve oral hygiene. This might commit proximal plaque levels to more accidental variability than cervical measures.

Another disadvantage of the present studies is that they did not assess the inter-rater concordance of MPI ratings. This is not one of the aims of the present study. Instead, it focused on the validity of the new parameter and maximized inter-rater concordance by calibration of the examiners. By using four examiners in study 2, who analyzed different subsamples of participants at each measurement point, data bias due to differential assessment skills and characteristics of individual examiners was avoided. Good validity coefficients underline the meaning of the parameters assessed. However, the studies allow no estimation of the inter-rater concordance of untrained or non-calibrated examiners. Although this is of minor importance for research studies, when examiners are calibrated routinely and intervention effects are focused, it is of considerable importance when it comes to comparison of absolute values between different studies or non-calibrated examiners. Future studies should thus assess the inter-rater concordance of MPI assessments of non-calibrated examiners and compare it to that of other PIs. Future research should also assess the benefits of the MPI in clinical settings. Clinical observations suggest that the index is easy to communicate to patients. It appears to be highly comprehensible for patients and helps periodontists to direct their attention to more critical areas. Still, these are non-systematic observations that should be verified by systematic studies.

CONCLUSIONS

The MPI allows for valid assessment of oral hygiene. It converges well with TQHI and is demonstrated to have similar concurrent and predictive validity for papillary bleeding. Its treatment sensitivity for interventions aiming at proximal hygiene or tooth-brushing exceeds that of the TQHI by far. This leads to a dramatic reduction of the sample size needed to discover statistically significant effects with an acceptable test power. Furthermore, the MPI allows for differentiation between proximal and cervical plaque and responds differently to treatments aiming at one or the other. Because it focuses on plaque accumulation at the gingival margin, it might be of special benefit for research and practice in periodontology in which marginal plaque is of particular importance.

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