Discrepancies in Periodontal Diagnosis and Classification Among Dental Practitioners with Different Educational Backgrounds

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Title:

Discrepancies in periodontal diagnosis and classification among dental practitioners with different educational backgrounds

Running title: Discrepancies in periodontal classification

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Abstract

Background: The 2017 classification of periodontal disease characterizes the disease with a multidimensional staging and grading system. The purpose of this multicenter study was to examine variations in periodontal diagnosis and classification among dental practitioners with different postgraduate educational backgrounds at the University of Maryland School of Dentistry and the Loma Linda University School of Dentistry using the 2017 classification.

Methods: This cross-sectional observational study included two cohorts: dental practitioners with periodontal backgrounds ($n_1 = 31$) and those with other educational backgrounds ($n_2 = 33$). The survey instrument contained three periodontal cases presented with the guidelines of the 2017 classification of periodontal disease and an open-ended questionnaire. The participants were asked to review each case and to fill out the questionnaire independently. Fisher's exact test was conducted to examine the difference and accuracy in responses between the two cohorts. Polychoric correlations were calculated to examine the relation between the level of familiarity with the 2017 classification and the accuracy of the diagnosis and classification.

Results: The distribution of item responses was significantly different between the two cohorts regarding only one item, grading for Case 1 ($p = 0.01$). No significant differences in accuracy between the two cohorts were observed except for two items, grading in Case 1 ($p = 0.03$) and staging in Case 3 ($p = 0.04$). There were no significant differences in risk factor identification for each case among the two cohorts ($p = 1.00$, Case 1; $p = 0.22$, Case 2). Staging in Case 3 ($\hat{p} = 0.52$) and risk factor identification in Case 2 ($\hat{p} = 0.32$) were significantly correlated with familiarity with the 2017 classification.

Conclusion: A fair level of agreement in periodontal diagnosis and classification was observed among dental practitioners with different educational backgrounds when the 2017 classification

was used. The periodontal cohort showed better agreement levels and partially better accuracy.

Risk factor identification for periodontal disease was difficult regardless of the educational background.

Keywords: Periodontology, Periodontal Diagnosis and Classification, Dental Education, Dental Practitioner

Background

Periodontitis is a progressive inflammatory disease and continues to be a major etiology for tooth loss (1). According to the data from the National Health and Nutrition Examination Survey (NHANES) 2009-12, the prevalence of periodontitis is 46%, with nearly 9% of severe cases of periodontitis in the US population aged ≥ 30 years (2). Providing comprehensive periodontal treatment in a timely manner is important to save natural teeth.

Diagnosis is the first important decision made by a practitioner for the patient and guides treatment planning. Moreover, diagnosis reflects the practitioner's knowledge, clinical insight, and problem-solving skills and it depends on two abilities: skill in detection during the examination and knowledge of the definition and criteria applied for identification of a disease or condition (3). Dental practitioners have noticed that there are obvious differences in the presentation of periodontal diseases among patients and have attempted to classify periodontal diseases (4). Classification systems have been developed to aid diagnosis and treatment decisions (5), yet even with these systems in place, considerable disagreements in diagnosis and classification have been reported among dental practitioners when using the 1999 classification of periodontal disease (6,7). These inconsistencies could cause over- or underestimation of the severity and extent of periodontal disease and may lead to inappropriate treatment selection for patients.

The 1999 classification of periodontal disease has been used during the past 17 years. Nevertheless, the 1999 system has several important weaknesses, including substantial overlap and a lack of clear pathobiology-based distinction between the specified categories, diagnostic indistinctness, and difficulties in implementation (8). While general practitioners (GPs) are patients' initial contact for seeking periodontal treatments and a primary source for referrals to

periodontists, a study found that only 62% of GPs felt confident in diagnosing aggressive periodontitis (9).

The 2017 classification was published to address the weaknesses of the 1999 classification. The diseases previously recognized as “chronic” or “aggressive” are now grouped under a single category, “periodontitis” and are further characterized based on a multidimensional staging and grading system (8,10). Staging is designed to categorize the severity and extent of chronic periodontitis and is determined based on the levels of clinical attachment loss (CAL) and the percentage of radiographic bone loss (RBL) around teeth. Grading is intended to indicate the rate of disease progression. The new classification recommends that clinicians should initially assign grade B and look for specific evidence to move to grade A or C. Risk factors for periodontal disease, such as diabetes and smoking, are grade modifiers (8).

To the best of our knowledge to date, no study has investigated variations in periodontal diagnosis and classification among dental practitioners with different educational backgrounds using the 2017 classification of periodontal disease. The purpose of this multicenter study was to examine variations in periodontal disease diagnosis and classification among dental practitioners with different postgraduate educational backgrounds at the University of Maryland School of Dentistry (UMSOD) and the Loma Linda University School of Dentistry (LLUSD) using the 2017 classification. The findings can provide feedback on the newly developed 2017 classification system and critical implications for dental educators in training both dental practitioners with and without a periodontal background. The following research questions (RQs) were set to make such contributions.

RQ1: Are there any significant differences in periodontal diagnosis and classification between the groups of dental practitioners with or without a periodontal background when using the 2017 classification system?

RQ2: Are there any significant differences in the accuracy of periodontal diagnosis and classification between the two groups of dental practitioners in comparison with the correct diagnosis that the expert panel agreed on?

RQ3: Does familiarity with the 2017 classification system influence the accuracy of the classification of each case?

To measure the accuracy of the classifications among dental practitioners, the responses of participants were compared to a consensus agreement on periodontal classification for each case drawn by an expert panel that included the principal investigator and two board-certified periodontists. The possible influence of familiarity with the new 2017 classification system on the accuracy of the classification of each case was also investigated.

Methods

Ethical approval

This study was conducted under a protocol approved by the institutional review board at the University of Maryland Baltimore (HP-00085364) and at Loma Linda University (5190255). A survey instrument in this study was developed by Se-Lim Oh (SO) and Yoon Jeong Kim (YK).

Study design and data collection

This cross-sectional observational study included two cohorts: dental practitioners with periodontal backgrounds and dental practitioners with other educational backgrounds. Faculty and postgraduate (PG) dental residents in periodontics at the UMSOD and the LLUSD and all PG dental residents in other dental disciplines at the UMSOD participated in this survey. PG

dental residents had graduated from dental schools and entered additional specialty training programs.

The survey instrument contained three periodontal patient cases presented with the guidelines of the 2017 classification of periodontal disease and an open-ended questionnaire. The guidelines for the new classification used in this study was taken from Tonetti et al (11). Table 1 presents the guidelines of the 2017 classification system provided to the participants in this study. The three periodontal cases (Cases 1, 2, and 3) were selected by SO and YK from the patient database in the UMSOD and LLUSD, which were considered to represent three different stages of periodontitis. The three cases were “real-life” cases without any alterations or modifications in the patients’ data. Each case presentation contained a brief medical and dental history, a full-mouth periodontal chart, intraoral clinical photographs, and intraoral complete radiographs without patient personal identifiers.

The participants were asked to review each case with the provided guide and fill out the questionnaire independently with no time restrictions. No personal identifiable information of the participant was associated with responses, and only codes for subgroups were used. Table 2 shows the open-ended questionnaire used in this study. Data collection was conducted from July 2019 to January 2020.

Study Sample

Table 3 summarizes the participants from each dental school. A total of 64 participants were included. In the periodontal cohort ($n_1 = 31$), faculty and PG residents from the two schools were recruited, while PG residents from only the UMSOD were recruited in the nonperiodontal cohort ($n_2 = 33$).

Statistical Analysis

After examining descriptive statistics, Fleiss' kappa and Kendall's coefficient of concordance (W) were first calculated to gauge the level of agreement and concordance over eight items among the overall participants as well as within each cohort. To examine the differences in the responses between the two cohorts of interest with respect to each item, Fisher's exact test was conducted (12). This decision was made because some of the Chi-squared approximation tests were predicted to be incorrect due to the small number of expected frequencies in the cross-tabulated cells (13).

To examine the differences in the accuracy of the responses between the two cohorts, the responses were dichotomously scored. The "correct" diagnosis and classification were determined by the three expert panel members whose agreement reached 100%. Then, the scored responses were compared between the two different cohorts using Fisher's exact tests with respect to each item.

To examine the relation between the level of familiarity with the 2017 classification and the accuracy of the diagnosis, polychoric correlations were calculated to address the nature of categorical responses that are ordinal but not interval. All analyses were conducted using R with the packages, polychor, psych, and irr (14–16). A p-value ≤ 0.05 was considered significant.

Results

Table 4 exhibits the number of participants and the distribution for levels of the acquaintance with the utilization of the 2017 classification in each cohort. Seventy-four percent of the periodontal cohort exclusively used the 2017 classification, while nearly 79% of the nonperiodontal cohort answered as either not aware of or not using the 2017 classification. As such, the distributions of responses appear significantly different between the two groups (Fisher's exact test; $p < 0.001$).

RQ1. Graph 1 shows the distributions of item responses on staging and grading with respect to each case among the participants. Across a total of six staging and grading items in three cases, the overall sample of 64 participants exhibited fair ($0.21 < \kappa < 0.40$) to moderate ($0.41 < \kappa < 0.60$) levels of agreement ($\hat{\kappa} = 0.34$, $z=61.1$, $p<0.001$) and concordance ($W=0.61$, $df=5$, $\chi^2=195$, $p<0.001$). Among the periodontal cohort, the agreement and concordance levels were higher ($\hat{\kappa} = 0.41$ $z=37.2$, $p<0.001$; $W=0.68$, $df=5$, $\chi^2=105$, $p<0.001$) than the corresponding coefficients calculated from the nonperiodontal cohort ($\hat{\kappa}=0.28$, $z=25.6$, $p<0.001$; $W=0.57$, $df=5$, $\chi^2=93.6$, $p<0.001$). In particular, the difference in $\hat{\kappa}$ estimates between the two cohorts was statistically significant at the $p=0.05$ level, indicating that a significantly higher level of agreement was observed within the periodontal cohort. Fisher's exact test for each item revealed that the distribution of item responses was significantly different between the periodontal and nonperiodontal cohorts with respect to only one item, the responses on grading for Case 1 (Fisher's exact test; $p = 0.01$).

RQ2. The correct diagnosis/classification rates for each item are reported in Table 5 along with the correct identification of risk factors for periodontal disease. The scored data analysis revealed that fewer than 50% of the total participants were successful on three out of eight items: risk factor identification for Case 1, risk factor identification for Case 2, and grade for Case 3. Generally, there were no significant differences in accuracy between the two cohorts except for two items; grading in Case 1 and staging in Case 3. For these items, the performance of the periodontal cohort was significantly better than that of the nonperiodontal cohort (Fisher's exact test; $p = 0.028$ for grading in Case 1 and $p = 0.045$ for staging in Case 3). There were no significant differences in the recognition of risk factors for each case among the two cohorts (Fisher's exact test; $p = 1.00$ for Case 1, $p = 0.22$ for Case 2).

RQ3. The polychoric correlations between familiarity with the 2017 classification and each scored item are presented in Table 6. Two statistically significant correlations were found between familiarity with the 2017 classification and staging in Case 3 ($\hat{\rho} = 0.52$, $SE=0.16$, $z=3.25$) and risk factor identification in Case 2 ($\hat{\rho} = 0.32$, $SE=0.18$, $z=2.25$). Given that the level of familiarity with the 2017 classification was confounded by the periodontal background, we also calculated the same correlations within each group. Once the periodontal background was controlled for, some of the correlations were negative for the nonperiodontal cohort, in which none of the participants were using the 2017 classification in their practice. This indicates who were not aware of or not using the guidelines of the 2017 classification performed better in diagnosis and classification when the guidelines were provided.

Discussion

Although researchers have made efforts to develop new technologies to improve diagnostic ability (17–20), periodontal diagnosis and classification are still formulated based on clinical and radiographic data collected by individual practitioners. A practitioners' ability to interpret and integrate the data obtained and critical thinking skills for clinical reasoning yields meaningful periodontal decisions (21). The purpose of this study was to examine the variations in periodontal diagnosis and classification among dental practitioners with different postgraduate educational backgrounds using the 2017 classification.

We found that there was a fair level of agreement among all participants and the agreement level was higher among the periodontal cohort than the nonperiodontal cohort when the 2017 classification was employed (Graph 1). This indicates that the 2017 system and guidelines were useful. Although fair to moderate agreement was obtained, the agreement was not at the satisfactory level, ranging from 30% to 83% at the most (Table 5). Even for the most

straightforward case from the investigators' point of view (Case 3), the grading accuracy was 36%. For only two items out of eight, the periodontal cohort demonstrated significantly better accuracy in periodontal diagnosis and classification (grading for Case 1 and staging for Case 3).

Grading, especially for new patients, could be challenging because dental practitioners often do not have previous periodontal records, such as CAL or RBL. Calculating the amount of CAL or RBL over 5 years, which was suggested as direct evidence in the 2017 classification (8), is difficult. Instead, dental practitioners often use the %bone loss/age index as indirect evidence. The goal of incorporating grading is to estimate the future risk of periodontitis progression and responsiveness to standard therapeutic principles to guide the intensity of therapy and monitoring (11). Grading is also designed for estimating the potential impact of systemic health on periodontitis to promote comanagement of patient health with medical teams (11). Having an accurate grade influences the management of the case, including the treatment goal, strategy, treatment modalities and/or sequence. It is suggested that education on the new 2017 classification system and training on how to use the guidelines for staging and grading should be incorporated into other PG dental education programs.

Identification of risk factors for periodontal disease is also difficult regardless of the educational background, as indicated by the low level of accuracy and the lack of a significant difference in the recognition of risk factors for the two cases (Cases 1 and 2) among the two cohorts. This may indicate that the concept of risk factors for periodontal disease is difficult to understand for most dental practitioners. Risk factors, when present in an individual, increase the chance of developing the disease by modifying host responses to the etiology, bacterial plaque, in periodontal disease (22). As risk factors play a role as grade modifiers in the grading system, emphasis on risk factors for periodontal disease in dental education is recommended.

Since the 2017 classification was published in 2018, many dental practitioners with other education backgrounds were not familiar with the 2017 classification. Interestingly, when the periodontal background was controlled for, some of the correlations between familiarity and accuracy for staging and grading were even negative for the nonperiodontal cohort (Table 6). This implies that dental practitioners who were not aware of or were not using the 2017 classification performed better in classification and diagnosis when the guidelines were provided. It is noteworthy that this result is only generalizable for the population of dental practitioners who have nonperiodontal backgrounds and have never used the 2017 classification. Among this population, the familiarity level is not a key to classifying periodontal disease.

The generalizability of this study results is limited due to a few factors. The sample size was relatively small, and only PG dental residents from the UMSOD were included in the nonperiodontal cohort. The number of cases and items for each case were small in the questionnaire. While the three patient cases were meant to represent different scenarios with the investigators' intention, more cases and items related to each case are necessary to cover contents related to periodontal diagnosis and classifications such as clinical and radiographic data assessments, local contributing factors for periodontal disease, and occlusal evaluation.

Conclusion

A fair level of agreement in periodontal diagnosis and classification was observed among dental practitioners with different educational backgrounds when the 2017 classification was used. The periodontal group showed better agreement levels and partially better accuracy. Identification of risk factors for periodontal disease was difficult regardless of the educational background.

Abbreviations

CAL clinical attachment loss

RBL radiographic bone loss

Declarations

Ethics approval and consent to participate

This study was conducted under an approved protocol by the institutional review boards (IRBs) at the University of Maryland Baltimore (HP-00085364), and at Loma Linda University (5190255). Obtaining the informed research consent was waived by the IRBs at the University of Maryland Baltimore and Loma Linda University.

Consent for publication

Not applicable

Availability of data and materials

The datasets used and analyzed in this study are available from the corresponding author upon reasonable request.

Competing interests

The authors report no conflicts of interest related to this study.

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Authors' contributions

SO designed the study, carried out the study, collected data, and participated in writing the manuscript. JY participated in designing the study, carried out the statistical analysis, and participated in writing the manuscript. YK collected data and participated in writing the manuscript. All authors have read and approved the manuscript, are aware of this submission, and agree with its publication.

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Table 1*. Summary of staging and grading in the 2017 classification for periodontal disease.

Staging	Periodontitis	Stage 1	Stage 2	Stage 3	Stage 4
Severity	Interdental CAL (at the site of greatest loss)	1-2 mm	3-4 mm	≥5 mm	≥5 mm
	RBL	Coronal third (<15%)	Coronal third (15%-33%)	Extending to the middle third of the root and beyond	Extending to the middle third of the root and beyond
	Tooth loss (due to periodontitis)	No tooth loss	No tooth loss	≤4 teeth	≥5 teeth
Complexity	Local	<ul style="list-style-type: none"> • Maximum PD ≤4 mm • Mostly horizontal BL 	<ul style="list-style-type: none"> • Maximum PD ≤5 mm • Mostly horizontal BL 	In addition to Stage 2 complexity <ul style="list-style-type: none"> • Maximum PD ≥6 mm • Vertical BL ≥3 mm • FI Class II or III • Moderate ridge defects 	In addition to Stage 3 complexity <ul style="list-style-type: none"> • Need for complex rehabilitation due to: <ul style="list-style-type: none"> - Masticatory dysfunction - Secondary occlusal trauma - Severe ridge defects - Bite collapse, drifting, flaring - <20 remaining teeth (10 opposing pairs)
Grading	Progression		Grade A: Slow rate	Grade B: Moderate rate	Grade C: Rapid rate
Primary criteria	Direct evidence of progression	RBL or CAL	No loss over 5 years	<2 mm over 5 years	≥2 mm over 5 years
	Indirect evidence of progression	% BL/age	<0.25	0.25 to 1	>1.0
		Case phenotype	Heavy biofilm deposits with low levels of destruction	Destruction commensurate with biofilm deposits	Destruction exceeds expectations given biofilm deposits
Grade modifiers	Risk factors	Smoking	Nonsmoker	<10 cigarettes/day	≥10 cigarettes/day
		Diabetes	Normoglycemic	HbA1c <7.0%	HbA1c ≥7.0%

CAL=clinical attachment loss; RBL=radiographic bone loss; PD=probing depth; BL=bone loss; FI=furcation involvement

*Table 1 adopted from Tonetti, Greenwell, Kornman. *J Periodontol* 2018;89 (Suppl 1): S159-S172 with permission from Wiley.

Table 2. Open-ended questionnaire used in this study.

<p>I am a postgraduate resident in _____.</p> <ol style="list-style-type: none">1. Periodontics2. Advanced General Dentistry3. Endodontics4. Prosthodontics5. Orthodontics
<p>How familiar are you with the 2017 periodontal disease classification?</p> <ol style="list-style-type: none">1. I am not aware that the 2017 periodontal classification is available.2. I am aware of the 2017 periodontal classification, but I am not using it in my practice.3. I am aware of the new periodontal classification and am in the process of integrating it into my practice.4. I am diagnosing patients exclusively using the 2017 periodontal classification.
<p>Case 1</p> <ol style="list-style-type: none">1) Based on the clinical and radiographic evaluation, diagnose this patient's periodontal disease with Stage and Grade.2) Does this patient have any risk factors for periodontal disease? If yes, please indicate the risk factor(s).
<p>Case 2</p> <ol style="list-style-type: none">1) Based on the clinical and radiographic evaluation, diagnose this patient's periodontal disease with Stage and Grade.2) Does this patient have any risk factors for periodontal disease? If yes, please indicate the risk factor(s).
<p>Case 3</p> <ol style="list-style-type: none">1) Based on the clinical and radiographic evaluation, diagnose this patient's periodontal disease with Stage and Grade.

Table 3. Summary of the participants

	Periodontal background	Nonperiodontal background
School (n)	UMSOD (12) LLSOD (19)	UMSOD (33)
Composition (n)	Faculty (13) PG residents (18)	All PG residents Advanced general dentistry (7) Prosthodontics (9) Endodontics (6) Orthodontics (11)

UMSOD = University of Maryland School of Dentistry; LLSOD = Loma Linda School of Dentistry; PG = postgraduate

Table 4. Distribution for levels of the acquaintance and the utilization of the 2017 classification among the participants (Fisher's exact test $p < 0.001$).

Participants	1 (not aware)	2 (aware but not using)	3 (in the process of integrating into practice)	4 (exclusively using the 2017 classification)
Practitioners with a periodontal background ($n_1 = 31$)	0	1 (3%)	7 (23%)	23 (74%)
Practitioners with other educational backgrounds ($n_2 = 33$)	9 (27.3%)	17 (51.5%)	7 (21.2%)	0
Overall (N = 64)	9 (14.1%)	18 (28.1%)	14 (21.9%)	23 (35.9%)

Note: % is the row percentage, rounded up to the first digit after the decimal point.

Table 5. Accuracy in the diagnosis/classification and recognition of risk factors for periodontal disease among the participants.

	Periodontal (n ₁ = 31)	Nonperiodontal (n ₂ = 33)	Overall N=64	Exact <i>p</i> - value
Case 1, Stage	0.52	0.48	0.50	1.00
Case 1, Grade	0.72	0.42	0.56	0.03*
Case 1, Risk factor	0.32	0.30	0.31	1.00
Case 2, Stage	0.68	0.64	0.66	0.80
Case 2, Grade	0.81	0.73	0.77	0.56
Case 2, Risk factor	0.48	0.30	0.39	0.22
Case 3, Stage	0.94	0.73	0.83	0.04*
Case 3, Grade	0.39	0.33	0.36	0.80

Note: Items with success rates lower than 50% are shown in gray.

Table 6. Correlation between familiarity with the 2017 classification and each item's performance.

	Periodontal cohort	Nonperiodontal cohort	Overall
Case 1, Stage	0.38	-0.60	-0.08
Case 1, Grade	0.17	-0.49	0.16
Case 1, Risk factor	0.86	-0.33	0.06
Case 2, Stage	0.44	-0.55	-0.06
Case 2, Grade	0.02	0.25	0.21
Case 2, Risk factor	0.41	0.44	0.32
Case 3, Stage	0.15	0.34	0.52
Case 3, Grade	0.11	0.06	0.12

Figure 1. Mosaic plot of the staging and grading for each case among the participants (total sample = 64; participants with a periodontal background = 31; participants with a nonperiodontal background = 33). Note: The p-value for Fisher's exact test is reported on top of each panel. The height of each box represents the proportion of each response category within a group, and the numbers in boxes represent the corresponding counts. The correct response categories are shown in gray.

Figures

Figure 1

Mosaic plot of the staging and grading for each case among the participants (total sample = 64; participants with a periodontal background = 31; participants with a nonperiodontal background = 33). Note: The p-value for Fisher's exact test is reported on top of each panel. The height of each box represents the proportion of each response category within a group, and the numbers in boxes represent the corresponding counts. The correct response categories are shown in gray.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [questionnaire.docx](#)