

Challenges and Decision Making for the Classification of Two Complex Periodontal Cases

Rafael Siqueira,* Nathalia Andrade,* Shan-Huey Yu,* Kenneth S. Kornman* and Hom-Lay Wang*

Focused Clinical Question: What are the fundamental debates and questions related to the newly developed two-vector system for classification of periodontal diseases that have emerged as to how to accurately assign, stage, and grade periodontitis cases? The aim of the present manuscript is to demonstrate the essential thought processes that are needed in utilizing the new periodontitis classification system to diagnose two gray zone cases.

Summary: Clinical case 1 includes an 83-year-old male diagnosed with periodontitis and classified as Stage III Generalized Grade B periodontitis, while clinical case 2, a 73-year-old male was classified as presenting Stage IV Generalized Grade B periodontitis. Although clinical and radiographic evaluations revealed similarities between the cases, the thought process that includes clinical judgment is described to guide a more accurate diagnosis following the guidelines of the new classification system.

Conclusion: The two cases demonstrated here offer an opportunity for clinicians to recognize the essential role of sound clinical judgment in certain cases when applying the new periodontal disease classification system and also clarify questions emerging from implementing this classification system. *Clin Adv Periodontics* 2021;11:103–110.

Key Words: Staging and grading of periodontal diagnosis; periodontal diseases; periodontal diagnosis; gray zones; periodontitis.

Background

In 2017, an international workshop co-sponsored by the American Academy of Periodontology and European Federation of Periodontology (AAP/EFP) gathered experts from around the globe to develop a new classification of periodontal and peri-implant diseases and conditions.¹ A new framework for stratifying periodontitis cases was derived from the long-used staging and grading approach to characterize tumors in oncology patients. The staging and grading was created to facilitate clinical practice, clinical research, as well as epidemiologic surveys.² Stage I to IV periodontitis is defined through carefully evaluating severity and complexity of management; the extent and pattern of the disease should be described additionally. Grade A, B, or C periodontitis is determined with direct or indirect evidence of progression rate in three categories: slow, moderate, and rapid progression. Also, risk factor analysis is used as a grade modifier.²

Since the proceedings of the new classification were published, the dental community has implemented it in both patient care and research. However, debates and questions of the new classification have also emerged as to how to accurately assign, stage, and grade periodontitis cases. In a follow-up report, Kornman and Papapanou, reiterated some basic principles, clarifying emerging ques-

tions to provide practical tips that will help clinicians use the new system to define periodontitis cases.³

Stage III and Stage IV cases may be similar in terms of clinical attachment loss (AL) ≥ 5 mm, radiographic bone loss (RBL) to the mid-third of the root length or beyond, tooth loss attributable to periodontitis, and probing depths (PD) ≥ 6 mm. Stage III and IV may also include vertical bone loss and Class II or III furcation involvement, as well as ridge defects secondary to periodontitis or ridge damage in response to loss of teeth. The above factors distinguish Stages III and IV from Stages I and II. The two cases reported in this manuscript present similarities on periodontal parameters in addition to age (>70 years, males), lack of periodontal maintenance, systemic diseases (cardiovascular/diabetes), and tooth loss (four and five teeth); however they were classified into two different staging categories (Stage III and IV).

Thus, the aim of the present manuscript was to demonstrate the essential thought process to utilize the new periodontitis classification system in two challenging cases with gray zones that might hinder straightforward case definition with stage and grade.

Clinical Scenario 1

Background Information

An 83-year-old male patient was referred (May, 2019) to the Graduate Periodontics Clinic (School of Dentistry, the University of Michigan) for treatment consult with the chief complaint “I want to have healthy teeth again.” His last periodontal maintenance was 1 month before

*Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI

Received August 26, 2020; accepted October 2, 2020

doi: 10.1002/cap.10126

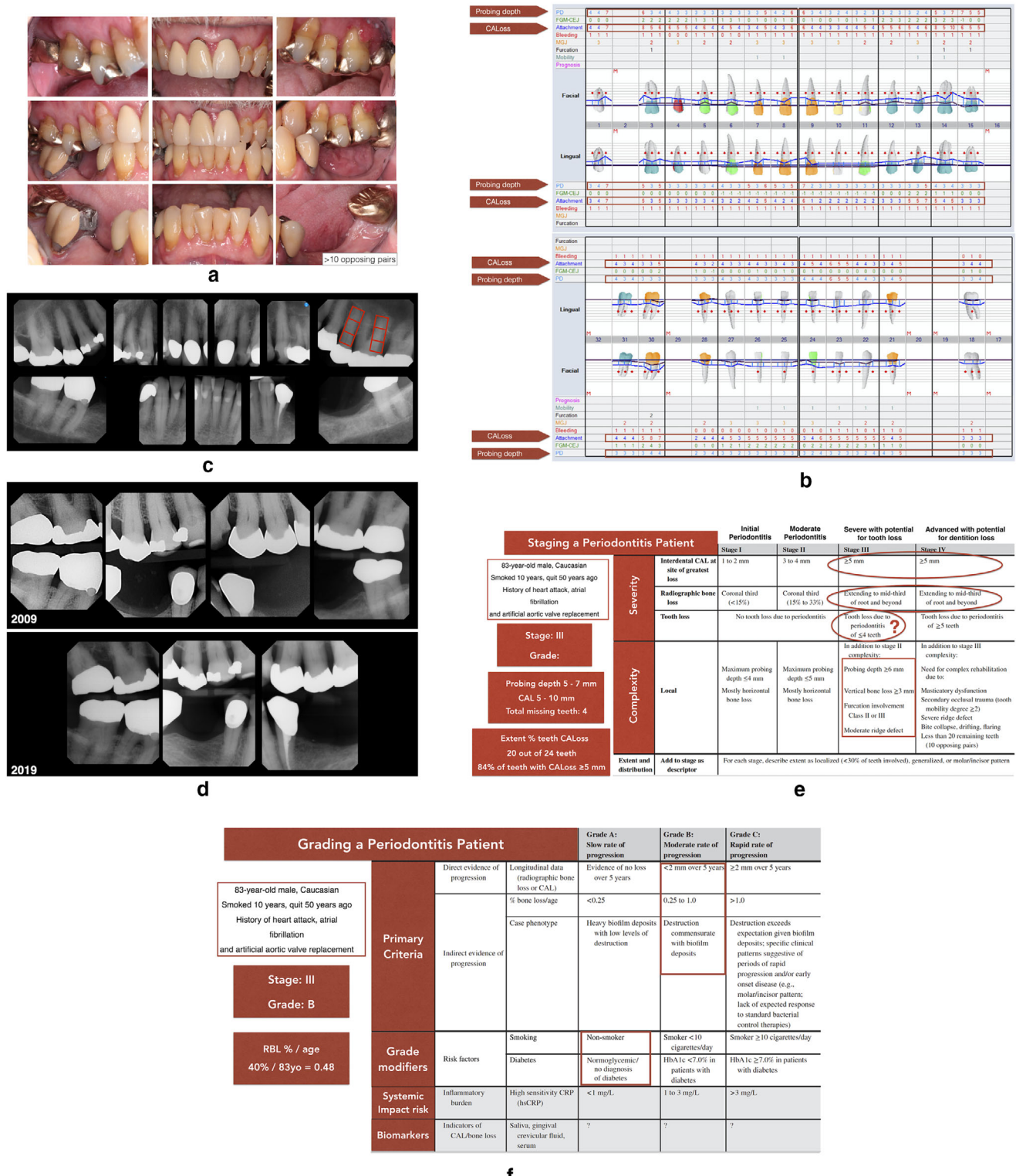


FIGURE 1 Case 1, clinical and radiographic information. **1a** Facial intraoral views divided by sextants. **1b** Initial maxillary and mandibular chart. **1c** Composition of intraoral radiographs. **1d** Longitudinal bitewing radiographs. **1e** Staging flowchart assessment. *Grading assessment is shown in panel f. **1f** Grading flowchart assessment. **Figure can be enlarged in online version of this article.**

visiting our clinic. However, the patient had not been compliant with maintenance recall due to a medical-related incidence (congestive heart failure) since 2016. **Figures 1a** through **1f** shows intraoral, periodontal, and radiographic findings. The key findings of the case including patient's medical history are summarized in **Table 1**.

Based on the new periodontal classification the patient was classified with Stage III Generalized Grade B periodontitis (**Table 1**).² In addition, other conditions affecting the periodontium were also identified: mucogingival deformities and conditions [generalized gingival recessions with interproximal AL less or equal to the buccal

TABLE 1 Summary of parameters identified for periodontal classification of clinical case 1

	Case 1
Age/sex	83 years/male
Relevant medical history	Controlled hypertension Stage 1, overweight (body mass index, 29.1), sleep apnea, allergy to penicillin, past-smoker (quit 50 years ago), heart attack (2003), atrial fibrillation (2007, 2014), artificial aortic valve replacement (2016)
ASA Classification	ASA 3
Current medications	Metoprolol 100 mg/d, atorvastatin 80 mg/d, aspirin 325 mg/d, warfarin 2mg/d, calcium 600 mg/d, ferrous sulfate 325 mg/d, folic acid 1 mg/d, garlic 500 mg/d, iron 650 mg/d, magnesium mg/d, and multivitamins 1 tab/d
BOP	87%
Severity	Interdental AL \geq 5 mm Radiographic bone loss: generalized moderate horizontal bone loss, with localized areas extending to the mid-third of the root (upper left posterior areas). Vertical bony defect was noted on #1 (tooth is mesially tilted). Missing teeth, n: 4 (unknown reasons)
Complexity	PD > 6mm, furcation ⁷ Class 2 (#30), moderate ridge defect, >10 opposing pairs
Extent and distribution	>84% of teeth affected (AL \geq 5 mm)
Evidence of progression	Direct evidence: <2 mm of bone loss in 5 years
Grade modifiers	Past-smoker (quit 50 years ago)/Non-diabetic
Oral hygiene	Poor—brushing 3 to 4 times per week with manual toothbrush, no use of floss or interdental cleaning
Occlusion	25 remaining teeth (>10 opposing pairs)/Class I Angle malocclusion (molar/canine) Crossbite on teeth #21, #22; supra-eruption of #4, #5, #13, #14; and anterior crowding. Protrusion: Anterior guidance Lateral excursive movements: group function with occlusal interferences on teeth #22, #21 (right), and #23 (left). Mobility ⁸ , Degree 1: #7, #8, #13, #14, #21 through #26 Fremitus: #7 and #8. No signs of parafunctional bruxism/0open contacts: #4 to #5; #21 to #22
Mucogingival characteristics	Gingival phenotype, thick/gingiva: erythematous, edematous, rolled margins/spongy, shiny Gingival recession ⁴ : RT2 = buccal: 3A-, 4A+, 5B-,6A-,7B-,8B-,9B-,10A+, 11A-, 12A-, 13A-, 15A-, 21B-, 22A+, 23B-, 24B-, 25B-, 26B-, 27A+, 28B-, 30B-, 31B-; lingual: 13B-, 14B-, 18B-, 24A-, 25A-, 26A-, 28B- RT3 = buccal: 14A-; lingual: 28B-, 30B- Keratinized gingiva: \geq 2 mm throughout the dentition
Other factors	¹ Inadequate restorations, biologic width intrusion (#30), root proximity ⁹ (lower anterior sextant—Division C—Severity 2), open contacts, secondary occlusal trauma (mobility and fremitus), recessions, and non-carious cervical lesions

ASA, American Society of Anesthesiologists; BOP, Bleeding on Probing.

site (RT2) and gingival recessions with interproximal AL higher than at buccal site (RT3)] thi;⁴ traumatic occlusal forces (secondary occlusal trauma); and tooth/prosthesis-related factors (inadequate restorations, cavities, and overhangs, supracrestal tissue attachment intrusion, open contacts, and root proximity). Each patient completed written informed consent at consultation, where treatment options were discussed in detail.

Decision Process for Diagnosis

The first step in the process of diagnosing a patient with periodontitis is to identify if we are dealing with a “true” patient with periodontitis, as AL can occur due to a variety of reasons such as: crown lengthening, gingival recession, tooth fracture, endodontic infection,

etc. This patient presented with interproximal AL of at least 5 mm at multiple non-adjacent teeth sites and bone loss is also confirmed through the radiographs indicating generalized horizontal bone loss limited to the coronal third with localized areas extending to the mid-third of root. Other forms of periodontitis including manifestation of systemic diseases or necrotizing periodontitis was ruled out after reviewing the clinical presentation and health history. Therefore, the diagnosis of periodontitis is established.

Staging and Grading Assessment

In this case, the severity score including AL \geq 5mm and areas of RBL extending to mid-root are clearly sufficient to place the patient to either Stage III or IV periodontitis

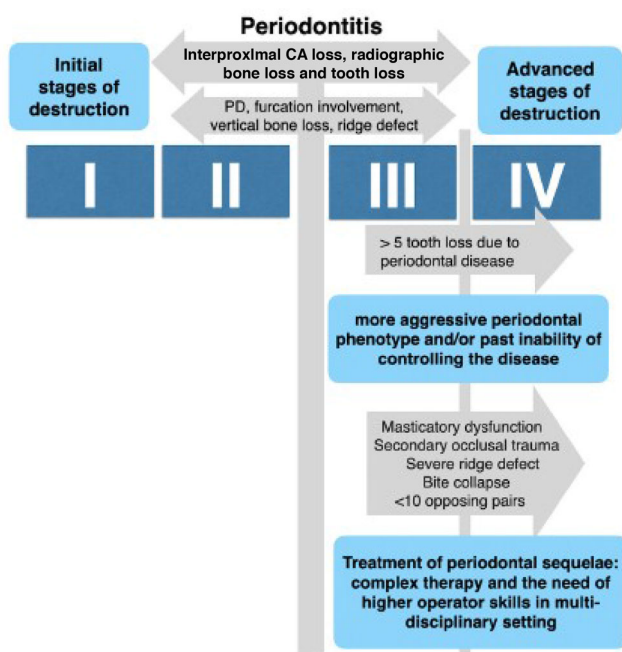


FIGURE 2 Simplified decision tree for staging assessment.

instead of Stage I or II. (Fig. 1e). However, the reasons for his tooth loss was not tracible, which is a common challenge that clinicians might encounter when utilizing this severity factor. The workshop suggested that staging should be primarily determined using clinical attachment level (CAL) this; if CAL is not available then RBL can be used. Number of tooth loss contributing from periodontitis can be used to modify the stage only if this information is made available. The next step will be to dissect the local complexity factors presented in this case that confirms Stage III periodontitis including PD ≥ 6 mm, Class II furcation involvement, and vertical bone loss at localized sites. Although one may argue that the patient presented the complexity factors of a Stage IV periodontitis: occlusal concerns due to edentulous sites require attention when rehabilitating. However, the condition is not extreme and the edentulism can be predictably managed with standard prosthodontic treatment such as removable partial denture, or dental implants. Furthermore, 84% of teeth presented with AL ≥ 5 mm, and therefore the extent of the periodontitis is considered generalized. Based on the comprehensive evaluation, the final stage assessment was Stage III generalized for this case.

Regarding grading, the new classification recommended to approach a case by assuming a moderate progression rate (Grade B) to start and look for direct and indirect measures of actual progression to improve the assessment. If evidence suggesting a slower progression rate, grading can be shifted to slower progression rate (Grade A). On the other hand, if clinical or medical history provides evidence of a more rapid progression, grading should be modified to grade C as an expectation that further tissue deterioration and/or a less favorable response to periodontal therapy could occur.^{2,5,6} In the present case, longitudinal data of bitewing radiographs were available

(Fig. 1d) to assess the direct evidence of disease progression: < 2 mm of bone loss over 5 years. Moreover, the patient did not present other grade modifiers. Thus, Grade B was the final assessment for this case (Fig. 1f). See simplified decision tree for staging and grading assessment (Fig. 2).

Clinical Scenario 2

Background Information

A 73-year-old male patient was referred for periodontal evaluation in July, 2019. The patient reported no discomfort or pain and his chief complaint was “I do not want to lose my teeth.” His dental history included scaling and root planing which was done 15 years ago. Figures 3a through 3f shows intraoral, periodontal, and radiographic findings. The key findings of the case including patient’s medical history are summarized in Table 2.

The dental diagnosis of this case includes bruxism, inadequate restorations, partial edentulism, hyper-eruption, and loss of occlusal vertical dimension. The periodontal diagnosis was defined as Stage IV generalized Grade B periodontitis (see Table 2), associated with drug-influenced gingival enlargement. Mucogingival deformities and conditions are also part of his diagnosis as the patient presented generalized gingival recessions RT1 and RT2,⁴ in addition to tooth- (open contacts) and prosthesis-related factors (inadequate restorations prone to biofilm accumulation, and bridges that were difficult to clean).

Decision Process for Diagnosis

This patient presented with interproximal AL ≥ 5 mm at multiple non-adjacent teeth sites and RBL indicating generalized 20% horizontal bone loss with localized areas extending to mid third of the root length. Other forms of periodontitis involving manifestation of systemic diseases or necrotizing periodontitis were discarded after appraisal of clinical presentation and health history. Thus, the diagnosis of periodontitis was established.

Staging and Grading Assessment

With the presentation of AL ≥ 5 mm and RBL, this case was placed in the Stage III or IV category right away. Again, the reasons for tooth loss were not available. Similar to case 1, case 2 also presented complexity factors such as PD ≥ 6 mm, vertical bone loss, and furcation involvement. However, unlike case 1, this case presented with deep bite, loss of vertical dimension, and severe wear which would require a complex rehabilitation. In general, Stage IV cases have < 10 opposing pairs and loss of vertical dimension which may be evident as drifting and flaring teeth and mobility of degree 2 or 3, clinical conditions that were encountered for this patient contrarily to case 1. Stage IV cases generally differ from Stage III in that Stage III patients are at risk for potential tooth loss whereas Stage IV cases have significant disease destruction that

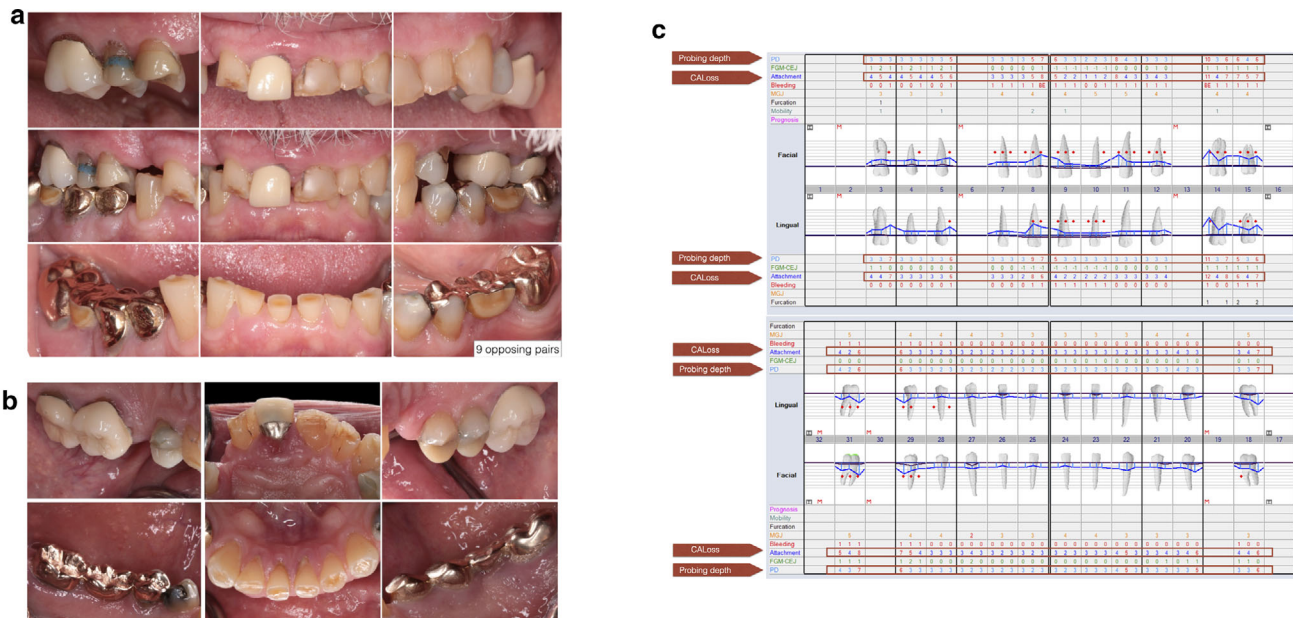


FIGURE 3 Case 2, clinical and radiographic information. **3a** Facial intraoral views divided by sextants. **3b** Lingual intraoral views divided by sextants. **3c** Initial maxillary and mandibular chart. **3d** Composition of intraoral radiographs. **3e** Staging flowchart assessment. *Grading assessment is shown in panel f. **3f** Grading flowchart assessment. **Figure can be enlarged in online version of this article.**

may have potential for loss of dentition. Therefore, the final stage assessment was Stage IV generalized as 50% of the patient's teeth presented $AL \geq 5$ mm (Fig. 3e).

When grading case 2, there was no available documentation for direct evaluation of disease progression. Indirectly inferred disease progression through percentage of bone loss/age (50%/73 years) revealed a 0.68 ratio, putting the patient in the Grade B category. Although the patient presented with a risk factor that could modify the grade, his diabetes was well-controlled ($HbA1c = 6.5\%$), and therefore we concluded Grade B for this patient (Figures 3f).

Discussion

While there are drastic differences between initial/moderate stages of periodontitis (Stage I/II) and severe/advanced forms (Stage III/IV), there are often gray areas and overlapping criteria when clinicians are trying to narrow down a case to either Stage III or IV category. Nevertheless, when assigning stage to a periodontitis case, this decision should not be made solely by “checking boxes” in the classification scheme. The use of sound clinical judgment is crucial when applying the new classification. Case 1 (Stage III) presents with factors that do not significantly affect the complexity of the treatment, the crowding and crossbite can lead to more plaque accumulation but can be controlled. On the other hand, case 2 is more challenging due to his complex occlusal problems that need to be addressed for a successful periodontal treatment. This is the major underlying reason for classifying case 2 as Stage IV periodontitis.

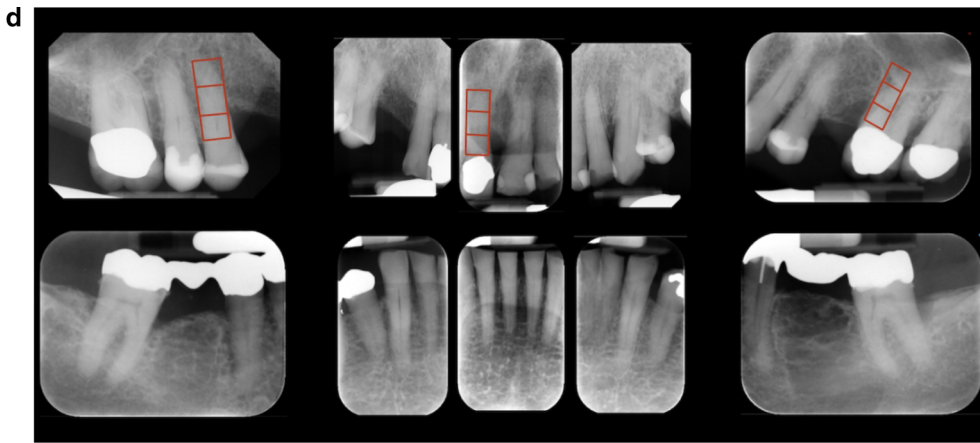
When assigning grades, the prioritization of direct evidence is advisable to recognize the rate of disease progression of the patient and build a customized therapy

on individual pattern. In the absence of direct evidence, indirect data verification is helpful. It was identified that case 2 (Stage 4) was not compliant with the periodontal maintenance program, had severe occlusal problems, and a grade modifier (diabetes) that could have not been under control over the years and thus contributed mostly for the past destruction. This fact brings the question on whether this case has a faster rate of progression compared with case 1. Nevertheless, there is no data to support a shift to Grade C. Case 1 (Stage 3) had a breakdown of the periodontal disease as an indirect effect of stroke, as he could not keep with maintenance recall for a few years, but in general the path of progression of his disease seems slower (patient is 10 years older when compared with case 2). Again, without direct evidence of a “true” slow progression there is no support for assigning Grade A to the patient.

We highlight the importance of understanding what is “behind” each parameter we analyze and the importance of clinical judgment to provide a comprehensive evaluation of each case. For a matter of providing concise and clear information, this paper focused on clinical judgment for assessing staging and grading, however we cannot forget the importance of other conditions affecting the periodontium and local and systemic related factors (Tables 1 and 2). A thorough evaluation of all those above-mentioned circumstances are mandatory for developing a comprehensive periodontal evaluation to finally lead to successful periodontal therapy.

Conclusions

This paper highlights the importance of using sound clinical judgment when applying the new classification



e Staging a Periodontitis Patient

		Initial Periodontitis Stage I	Moderate Periodontitis Stage II	Severe with potential for tooth loss Stage III	Advanced with potential for dentition loss Stage IV
Severity 73-year-old male, Caucasian Non-smoker Controlled Hypertension Stage 1 Type 2 diabetes (HbA1c - 6.5%) Stage: III Grade: Probing depth 5 - 11 mm CAL 5 - 12 mm Total missing teeth: 4 Extent % teeth CALoss 12 out of 24 teeth 50% of teeth with CALoss ≥5 mm	Interdentary CAL at site of greatest loss	1 to 2 mm	3 to 4 mm	≥5 mm	≥5 mm
	Radiographic bone loss	Coronal third (<15%)	Coronal third (15% to 33%)	Extending to mid-third of root and beyond	Extending to mid-third of root and beyond
	Tooth loss	No tooth loss due to periodontitis		Tooth loss due to periodontitis of ≤4 teeth	Tooth loss due to periodontitis of ≥5 teeth
Complexity Local		Maximum probing depth ≤4 mm Mostly horizontal bone loss	Maximum probing depth ≤5 mm Mostly horizontal bone loss	In addition to stage II complexity: Probing depth ≥6 mm Vertical bone loss ≥3 mm Furcation involvement Class II or III Moderate ridge defect	In addition to stage III complexity: Need for complex rehabilitation due to: Masticatory dysfunction Secondary occlusal trauma (tooth mobility degree ≥2) Severe ridge defect Bite collapse, drifting, flaring Less than 20 remaining teeth (10 opposing pairs)
	Extent and distribution	For each stage, describe extent as localized (<30% of teeth involved), generalized, or molar/incisor pattern			

f Grading a Periodontitis Patient

		Grade A: Slow rate of progression	Grade B: Moderate rate of progression	Grade C: Rapid rate of progression	
73-year-old male, Caucasian Non-smoker Controlled Hypertension Stage 1 Type 2 diabetes (HbA1c - 6.5%) Stage: III Grade: B RBL % / age RBL 50% / 73yo = 0.68	Primary Criteria Direct evidence of progression	Longitudinal data (radiographic bone loss or CAL)	Evidence of no loss over 5 years	<2 mm over 5 years	≥2 mm over 5 years
		Indirect evidence of progression	% bone loss/age	<0.25	0.25 to 1.0
	Grade modifiers Risk factors	Smoking	Non-smoker	Smoker <10 cigarettes/day	Smoker ≥10 cigarettes/day
Diabetes		Normoglycemic/ no diagnosis of diabetes	HbA1c <7.0% in patients with diabetes	HbA1c ≥7.0% in patients with diabetes	
Systemic Impact risk	Inflammatory burden	High sensitivity CRP (hsCRP)	<1 mg/L	1 to 3 mg/L	>3 mg/L
Biomarkers	Indicators of CAL/bone loss	Saliva, gingival crevicular fluid, serum	?	?	?

FIGURE 3 Continued

of periodontal diseases. The two cases demonstrate an opportunity for clinicians to clarify questions emerging from implementing this classification scheme in both patient care and research projects.

Acknowledgments

The authors do not have any financial interests, either directly or indirectly, in the products or information listed in the paper. This paper was partially supported by the

TABLE 2 Summary of parameters identified for periodontal classification of clinical case 2

	Case 2
Age/sex	73 years/male
Relevant medical history	Controlled hypertension Stage 1, obesity (body mass index, 34), irregular heartbeat, type 2 diabetes (last HbA1c - 6.5%), basal cell carcinoma (removed in 2017).
ASA Classification	ASA 2
Current medications	Aspirin 81 mg/d, amlodipine 10 mg/d, fenofibrate 67 mg/d, glimepiride 2 mg/d, insulin 18 units/d, lisinopril 40 mg/d, metformin 500 mg 2x/d, metoprolol succinate 100 mg/d, eliquis 5 mg 2x/d, and multivitamins 1 tab/d
BOP	56%
Severity	Interdental AL \geq 5 mm Radiographic bone loss: generalized mild horizontal bone loss with localized severe bone loss on #5. Vertical bony defects noted on #8, #11, #14, #18, #29, #31. Missing teeth, n: 5 (unknown reason)
Complexity	PD $>$ 6 mm, vertical bone loss $>$ 3 mm, furcation ⁷ Class 2 (#15), moderate ridge defect, $<$ 10 opposing pairs, mobility ⁸ Class 2, #8 with fremitus
Extent and distribution	$>$ 50% of teeth affected (AL \geq 5 mm)
Evidence of progression	Indirect evidence: 0.68 (bone loss/age) Destruction commensurate with biofilm deposits
Grade modifiers	Non-smoker/diabetes type 2 (last HbA1c, 6.5%)
Oral hygiene	Fair-brushing 2 to 3/d with electric toothbrush, use of floss 2 to 3 times/wk
Occlusion	23 remaining teeth (9 opposing pairs)/ Angle classification could not be determined Deep bite; loss of vertical dimension; #27 supra-erupted Protrusion: Anterior guidance (interference of #8) Lateral excursive movements: group function with occlusal interferences on teeth #7/#27 (right) Hyper-eruption of upper anterior teeth Mobility ⁸ , Degree 1: #5, #9, #14, Degree 2: #8 Fremitus: #8. Parafunctional bruxism Open contacts: #8 and #9, #21 and #22; #22 and #23; #23 and #24, #24 and #25, #25 and #26, #28 and #29.
Mucogingival characteristics	Gingival phenotype, thick/gingiva: erythematous, edematous, bulbous, with hyperplasia, spongy, shiny Gingival recession ⁴ : RT1 = buccal: #3B-, #4B-, #21B-, #27A+; lingual: #12B-, #23A+, #A+, #26A- RT2 = buccal: #5B-, #8B-, #9B-, #11A-, #12B-, #14B-, #15B-, #18 B-, #20A+, #29A-, #31B-; lingual: #3B-, #5B-, #8B-, #12B-, #14B-, #15B-, #18B-, #20B-, #29B-, #31B- Keratinized gingiva: $>$ 2 mm throughout the dentition
Other factors	Inadequate restorations, open contacts, secondary occlusal trauma (indicated through fremitus, mobility, occlusal discrepancies, wear facets), recessions

ASA, American Society of Anesthesiologists; BOP, Bleeding on Probing; HbA1c, Glycated hemoglobin.

University of Michigan Periodontal Graduate Student Research Fund. The authors report no conflicts of interest related to this paper.

Author Contributions

Rafael Siqueira, Nathalia Andrade, Shan-Huey Yu, Kenneth S. Kornman, and Hom-Lay Wang were responsible for case documentation, drafting the manuscript, and preparation and final revision.

CORRESPONDENCE

Hom-Lay Wang, Department of Periodontics and Oral Medicine, University of Michigan School of Dentistry, 1011 North University Avenue, Ann Arbor, MI 48109-1078.
E-mail: homlay@umich.edu

References

1. Caton JG, Armitage G, Berglundh T, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. *J Periodontol* 2018;89(Suppl 1):S1-S8.
2. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: framework and proposal of a new classification and case definition. *J Periodontol* 2018;89(Suppl 1):S159-S172.
3. Kornman KS, Papapanou PN. Clinical application of the new classification of periodontal diseases: ground rules, clarifications and "gray zones". *J Periodontol* 2020;91:352-360.
4. Cairo F, Nieri M, Cincinelli S, Mervelt J, Pagliaro U. The interproximal clinical attachment level to classify gingival recessions and predict root coverage outcomes: an explorative and reliability study. *J Clin Periodontol* 2011;38:661-666.
5. Papapanou PN, Sanz M, Buduneli N, et al. Periodontitis: consensus report of workgroup 2 of the 2017 world workshop on the classification

of periodontal and peri-implant diseases and conditions. *J Periodontol* 2018;89 Suppl 1:S173-S182.

6. Ravida A, Qazi M, Troiano G, et al. Using periodontal staging and grading system as a prognostic factor for future tooth loss: a long-term retrospective study. *J Periodontol* 2020;91:454-461.

○ indicates key references.

7. Hamp SE, Nyman S, Lindhe J. Periodontal treatment of multirrooted teeth. Results after 5 years. *J Clin Periodontol* 1975;2:126-135.
8. Miller SC. *Textbook of Periodontia*. Philadelphia: The Blakiston Co; 1938.
9. Vermylen K, De Quincey GN, Wolffe GN, van 't Hof MA, Renggli HH. Root proximity as a risk marker for periodontal disease: a case-control study. *J Clin Periodontol* 2005;32:260-265.