Periodontal Screening and Recording (PSR) Index Scores Predict Periodontal Diagnosis

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Abstract

Objective: The objective of this study was to determine the probability of periodontal disease diagnosis given the highest Periodontal Screening and Recording Index (PSR) encountered during a screening exam. Diagnostic characteristics of the PSR in a large number of adults attending a dental school clinic were determined.

Materials and Methods: In this cross-sectional study of 2299 adult patients attending a dental school clinic, PSR scores were correlated to periodontal diagnoses based on attachment levels, and sensitivity, specificity, predictive value of the PSR were determined..

Results: The highest PSR score correlated well with eventual periodontal diagnosis and PSR scores display high specificity in regards to periodontal diagnosis. Patients with PSR scores of zero are most likely periodontally healthy with no history of attachment loss (in 93% of cases); PSR scores less than 3 most likely indicate plaque-induced gingivitis (79% of cases), and a PSR score of 4 usually indicates chronic periodontitis (81% of cases).

Conclusions: Although not intended for diagnosis, PSR scores can be used to predict periodontal diagnosis. This also applies to CPITN scores as the scoring system is the same, and known diagnostic characteristics of the CPITN are similar to the diagnostic characteristics of the PSR observed in this study.

Keywords: Epidemiology; Gingivitis; Chronic periodontitis

Abbreviations

AAP: American Academy of Periodontology; CPITN: Community Index of Periodontal Treatment Needs; NHANES: National Health and Nutrition Examination Survey; PSR: Periodontal Screening and Recording Index.

Introduction

Diagnosis of periodontal disease often involves a comprehensive periodontal exam including full mouth probing and measurement of attachment levels. Since these examsare time intensive and often require a dental assistant for charting,epidemiologic studies often use the Community Periodontal Index of Treatment Needs (CPITN) as defined by Ainamo et al. [1], to estimate periodontal disease and treatment needs. For the same reasons, it appears that general dentists tend not to perform full periodontal exams [2], and it has been suggested that general dentists should use the CPITN to facilitate identification of periodontal disease [3]. Following this suggestion, the American Dental Association and American Academy of Periodontology developed the Periodontal Screening and Recording Index (PSR)to improve periodontal disease detection and collaboration between general dentists and periodontists. The PSR is derived from the CPITN, uses the same specialized probe [4] and scoring system [5], and involves probing of all teeth. Based on the site with the worst probing depth, calculus and gingival bleeding, scores are assigned to each sextant. It has been suggested that for patients with none or mild periodontal disease (scores 0 to 2), PSR scores may suffice as periodontal record, whereas PSR scores of 3 (highest probing depth 5.5 mm) in two or more sextants, or a PSR score of 4 (probing depth greater than 5.5 mm) in any sextant would warrant further periodontal assessment [6], although the scientific evidence for this suggestion is unclear.

Even though PSR and CPITN systems may be useful for screening purposes, scores are not diagnostic since neither system measures clinical attachment levels. To our knowledge, no study exists that correlates PSR and CPITN scores to periodontal diagnoses based on attachment levels. In order to correct this deficit, we determined in this cross sectional study of adults attending a large general practice dental clinic the correlation between highest PSR score and periodontal diagnosis. Along with diagnostic probabilities of each PSR score, we also determined prevalence, predictive values, sensitivity, specificity, and reliability for the PSR system, as existing data is limited. Findings from this study should allow clinicians to predict the likelihood of certain periodontal diseases based on PSR scores alone, and allow periodontal disease prevalence estimates from epidemiologic studies that report PSR and CPITN scores.

Materials and Methods

Subjects

This study was a retrospective study of records from 3426 individuals who registered as patients at the Western University of

Health Sciences Dental Center between September 2010 and April 2013. Records were excluded from this study for the following reasons: patient was unable to provide consent for examination, treatment, and use of records for research; patient did not receive a complete oral examination including PSR and periodontal diagnosis; patient was edentulous resulting in no PSR scores and periodontal diagnosis.

After applying exclusion criteria, 2299 patient records were reviewed to determine PSR-periodontal diagnosis correlation. Demographic information, medical history and dental findings were also retrieved to test if the dental school clinic's patient population was representative of the community at large. The study was approved by the Western University of Health Sciences Institutional Review Board (IRB#12/IRB/019) and has been conducted in full accordance with ethical principles outlined in the Declaration of Helsinki.

Setting

The Dental Center is a dental school clinic that was designed to mimic a large general dentistry group practice, and advertised as such attracting patients with general dentistry needs. Pairs of third and fourth year dental students provided basic patient care similar to a dental assistant-associate dentist pairing, and a licensed general dentist managing and supervising six student pairs. For examination and diagnosis, students examined a patient and assigned a diagnosis, which was then verified by a supervising dentist. As part of gaining clinic privileges, students and dentists were calibrated on performing PSR assessments and periodontal exams using slide presentations and video clips by a periodontist (TB). Dentists, students and periodontists were also calibrated by TB to use same amount of probing force (20g) using a letter scale (Escali, Minneapolis, Wisconsin) as part of initial calibration, and randomly thereafter.To ensure continued calibration, periodontist TB also randomly calibrated dental students and dentists individually throughout the years of this studyon live patients, and audited all patient records for diagnostic consistency.

Examination Procedure and Periodontal Diagnosis

Prospective patients were initially seen for a screeningexam to determine if their treatment needs could be met at the Dental Center, and this screening included a first PSR assessment. If accepted for treatment, patients would be seen for a comprehensive oral exam that included a second PSR assessment, and periodontal diagnosis based on attachment level as outlined in supplemental table S1, and following largely the current periodontal disease definitions as outlined by the 1999 International Workshop Classification of Periodontal Disease

Supplemental Table S1: Periodontal Disease and Condition Definitions.

Condition (AAP Category)	B.O.P	Max CAL	Max ABL	Other criteria
Health (0)	None	0	2	No periodontal abnormality
Plaque-associated gingivitis (1)	Yes	0	2	Amount of plaque present appears appropriate for amount of inflammation observed
Diabetes mellitus-associated gingivitis (1)	Yes	0	2	Uncontrolled diabetes mellitus Disproportionately high amount of inflammation seen with little plaque
Pregnancy associated gingivitis (1)	Yes	0	2	Pregnancy Disproportionately high amount of inflammation seen with little plaque
Oral contraceptive associated gingivitis (1)	Yes	0	2	Oral contraceptive use Disproportionately high amount of inflammation seen with little plaque
Puberty-associated gingivitis (1)	Yes	0	2	Puberty Disproportionately high amount of inflammation seen with little plaque
Pseudopocket (1)		0		Pocket depth > 5 mm
Gingival disease not associated with plaque (1)		0		Not responsive to oral hygiene Biopsy indicated other disease process than periodontal infection
Mild chronic periodontitis (2)		1-2		Generally older than 29 years Periodontal Inflammation related to plaque/calculus level
Moderate chronic periodontitis (3)		3-4		Generally older than 29 years Periodontal Inflammation related to plaque/calculus level
Severe chronic periodontitis (4)		≥5		Generally older than 29 years Periodontal Inflammation related to plaque/calculus level
Aggressive Localized Periodontitis (4)		>0		Generally younger than 30 years Relatively low amount of plaque Attachment loss around molars and incisors only
Periodontal abscess		>0		Suppuration evident
Gingival abscess		0		Suppuration evident
Pericoronal abscess				Suppuration evident Tissue flap over occlusal surface
Combined perio-endo lesion				Probing depth to apex of non-vital tooth. Radiographic bone loss to ape of non-vital tooth
Conditions not associated with periodontal disease	None	0		Any abnormality seen in absence of any current periodontal disease.
Significant periodontal disease				Chronic Periodontitis Aggressive Periodontitis Combined Perio-Endo lesions Abscesses of the Periodontium Necrotizing Periodontal disease (none found) Periodontitis as Manifestation of Systemic Disease (none found)

B.O.P.: Any bleeding on probing that is apparent within a few seconds of probing
CAL: Interproximal clinical attachment level (in mm) as measured from CEJ to base of periodontal sulcus
ABL: Interproximal alveolar bone level (in mm) as measured from CEJ to radiographic bone level
AAP Category: Disease categories defined by the American Academy of Periodontology.

Table 1: Inter-examiner reliability improves with increasing PSR score.

Average Highest PSR score	Screening Exam	3.00 +/- 0.884
	Comprehensive Exam	3.01 +/- 0.884[ns]
		% Agreement
Screening PSR vs. Initial Exam PSR		76
If screening PSR=4		82
If screening PSR=3		75
If screening PSR=2		74
If screening PSR=1		46
If screening PSR=0		56

Percent agreement between highest PSR scores at screening appointment and initial exam appointment.

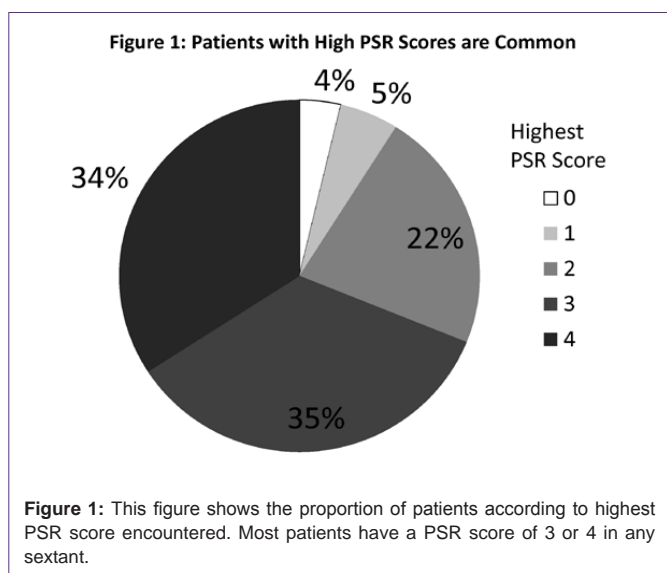[ns]: No significant difference (p=0.2998, Mann-Whitney U-test)

Figure 1: This figure shows the proportion of patients according to highest PSR score encountered. Most patients have a PSR score of 3 or 4 in any sextant.
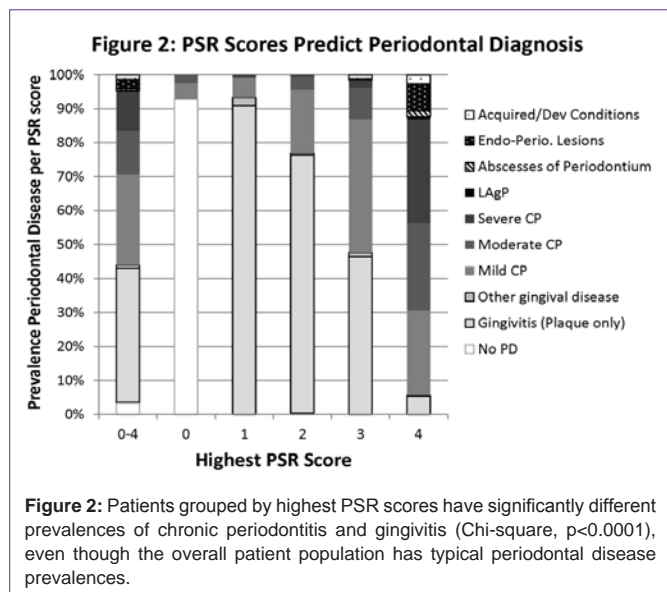

Figure 2: Patients grouped by highest PSR scores have significantly different prevalences of chronic periodontitis and gingivitis (Chi-square, p<0.0001), even though the overall patient population has typical periodontal disease prevalences.

[7]. Both PSRs were used to determine interexaminer reliability of PSR measures, and the highest PSR score determined the comprehensive exam correlated with periodontal diagnosis made by periodontist TB.

Periodontist TB determined periodontal diagnosis by measuring attachment levels independently from the general dentist/student team either at the exam appointment, or at a subsequent appointment within a few weeks of the exam. Diagnosis made by the general dentist/student team and the periodontists were used to determine inter-examiner diagnostic reliability.

Statistical analysis

For assessment of inter-examiner reliability, we determined kappa by correlating American Academy of Periodontology Disease (AAP) Categories assigned independently by the dentist/student team and the periodontist, and by correlating PSR scores measured during the screening exam and during the subsequent comprehensive exam.

In addition, contingency tables for various periodontal disease diagnoses and PSR scores were constructed to determine probability of diagnosis, receiver-operator curves, sensitivity, specificity and predictive values. For tabulation of data we used Microsoft Excel 2010 (Redmond, WA), and analyzed the data using GraphPad Prism 6.02 (LaJolla, CA).

Results

Calibration of the different providers regarding periodontal diagnosis was nearly ideal as determined by correlating diagnoses made by the periodontist and the general dentist/student teams. Interexaminer agreement was very good (examiners agreed 95% on diagnoses, kappa was 0.936 with a standard error 0.012; Pearson coefficient was 0.968 (95% confidence interval 0.962 to 0.972). If there was disagreement, assigned AAP categories were only off by one category most of the time. Therefore, we concluded that there was little disagreement between the periodontist and calibrated general dentist/student teams, and that the diagnostic process was extremely reliable.

Calibration of the different providers regarding PSR scoring was successful as PSRs determined by different providers at separate appointments did not differ on average between appointments (Table 1). Interexaminer agreement between PSR scores was good (examiners agreed 76% of observations, kappa=0.643 with standard

Table 2: Diagnostic characteristics of PSR scores.

Periodontal Disease	PSR Score	Sensitivity %	Specificity %	Probability of disease / PPV %	NPV %
No Disease	0	97.56098	99.72863	93.02326	99.90938
Plaque-associated Gingivitis	1	12.11454	99.20578	90.90909	63.25967
	1-2	54.62555	90.39711	78.85533	75.24038
Chronic Periodontitis	3-4	88.82253	52.09634	65.96958	81.67832
	4	54.26621	90.33752	81.32992	71.80431
Significant Periodontal Disease	4	81.46417	84.31254	66.8798	92.12442

PSR scores are highly specific for common periodontal diseases, but may not be very sensitive. Patients with a PSR score of 1 to 2 are unlikely to have any form of periodontitis, whereas patients with PSR scores of 3 and 4 are unlikely to have gingivitis. A PSR score of 0 most likely is indicative of periodontal health in the absence of attachment loss. PPV: Positive predictive value, or probability of having a certain periodontal disease given the highest PSR score. NPV: Negative predictive value. Significant Disease: Chronic periodontitis, Aggressive periodontitis, Abscesses, Endo-Perio lesions – diseases that most likely will need substantial periodontal therapy.

Supplemental Table S2: Probability of having which type of periodontal disease given a highest PSR score.

Highest PSR score Periodontal Disease	Any	0	1	2	3	4
None	0.036	0.930	0	0.004	0	0
Gingivitis, plaque-associated	0.396	0	0.909	0.760	0.465	0.054
Other gingival disease	0.008	0	0.025	0.006	0.013	0.004
Chronic periodontitis, Mild	0.267	0.047	0.058	0.187	0.392	0.249
Chronic periodontitis, Moderate	0.130	0.023	0	0.037	0.093	0.258
Chronic periodontitis, Severe	0.114	0	0.008	0.006	0.024	0.306
Localized Aggressive Periodontitis	0.003	0	0	0	0	0.008
Abscesses of the Periodontium	0.006	0	0	0	0.001	0.017
Combined endo-perio lesion	0.027	0	0	0	0	0.081
Acquired/ Developmental Cond.	0.013	0	0	0	0.013	0.024

Condition	Probability
If highest PSR score is either 1 or 2, likelihood of plaque-associated gingivitis	0.789
If highest PSR score is 2, likelihood of having plaque-associated gingivitis or mild chronic periodontitis	0.947
If highest PSR score is 3, likelihood of having plaque-associated gingivitis or mild chronic periodontitis	0.857
If highest PSR score is 4, likelihood of having chronic periodontitis	0.813

Even though a PSR score is not used for periodontal diagnosis, there is a clear association between the highest PSR score in the mouth and periodontal disease. If a patient has PSR scores of 0 everywhere, there is a 93% chance that the patient never had periodontal disease. If a patient has PSR scores not greater than 1, there is a 91% chance the patient has plaque-associated gingivitis.

Supplemental Table S3: Patients with PSR scores of 4 tend to be older than 35 years

Age	% of patients with a highest PSR score of 4	% of patients with periodontitis
18-24	5.2	1.4
25-34	10.8	13.5
35-44	25.6	58.0
45-54	31.1	75.5
55-64	31.8	87.1
>64	32.0	92.6

error of 0.017; Pearson r coefficient was 0.8002 (95% confidence interval 0.7796 to 0.8190)). If there was disagreement, PSR scores were usually only off by a score of one, and agreement increased with increasing PSR scores (Table 1). Based on our PSR data and subsequent probing depth data, we estimated the chance of missing a pocket deeper than 5 mm during a PSR screening to be 0.9%

High PSR scores were the most common, as an about a third of our subjects exhibited PSR scores of 4 during the comprehensive exam, and another third had a highest PSR score of 3 (Figure 1). Only 4% of patients exhibited lack of gingival bleeding, absence of pocketing greater than 3.5 mm and had no calculus anywhere.

To determine predictive potential of the PSR, we correlated PSR and AAP Disease Categories, and found a significant correlation of PSR scores with periodontal disease (R^2=0.43, p<0.0001), and PSR scores a fairly accurate predictor of AAP Disease category. (Area under receiver-operator curve=0.73, p<0.0001). It has also been found that if patients are grouped according to their highest PSR score, absence of periodontal disease, presence of gingivitis and chronic periodontitis are significantly different in each group (Figure 2, Chi-square analysis, p<0.0001). We also determined the probabilities of

a subject having a certain periodontal disease given the highest PSR score found during the comprehensive exam. In addition, we listed diagnostic characteristics of the PSR for each condition (Supplemental Table S2, Table 3).

Although the PSR was not intended to be used for diagnosis of periodontal disease, significant correlations have been found between the PSR and periodontal disease diagnosis. This was found in a dental school clinic patient population which is older than the U.S. average individual, has slightly higher levels of chronic periodontitis (53% vs. 47%) and has levels of systemic diseases known to affect periodontal disease at a similar or slightly lower level than national average [8]. Since the patients in this study exhibit similar level of disease compared to the national average, we believe that results from this study should be applicable to average patients.

Discussion

The prevalence of a highest PSR score of 4 is 34% in our clinic patients, which is lower than reported for Greek farm workers by Diamanti-Kipioti et al. (47%) [9], and higher than reported for U.S. military personnel by Covington et al. (17%) [10]. Since levels of attachment loss increase with increasing age, and Covington's subjects have a much loweraverage age (33.3 years) compared to our patient population (45.3 years), we assume that Covington's subjects have less attachment loss than our subjects. Since attachment loss is associated with a high PSR score in our study, we would expect lower PSR scores in younger patients. In our patient population, patients with PSR scores of 4 are uncommon under the age of 35 and periodontitis becomes prevalent only after age 40 (Supplemental Table S3). The farm workers average age is the similar to our patient population, but also features a higher prevalence of edentulism (7.4%) than our patient population (1.2%), and seems to have much higher levels of periodontitis as 93% of subjects had attachment loss greater

than 1 mm. Therefore, the percentage of subjects with a PSR score of 4 in a given study is directly correlated with the age of the study subjects and the prevalence of attachment loss in that study.

Khocht's finding that PSR scores of 3 and 4 are the most common PSR scores was also observed in our study, and PSR scores of 0 were quite rare. As expected from NHANES data, and from analysis of periodontal disease prevalences in our patient population, PSR scores of 3 and 4 should be frequent given that nearly 95% of adults have periodontal disease and exhibit gingival inflammation [8,11].

The operating characteristics we determined for the PSR are quite similar to the characteristics determined for the full-mouth CPITN by Bassani et al [12]. The receiver operator curve area for the full mouth CPITN was 0.69 compared to 0.73 for the PSR, and the difference appears not to be clinically relevant as both scores correlate well with periodontal disease severity. Sensitivity for periodontal disease with attachment loss of 3 mm was 58% in their study, while here it is 54% for any form of chronic periodontitis or any interproximal attachment loss. Specificity was 81% in their study, compared to 90% in this study. Positive predictive value and negative predictive values were much higher in this study, most likely because the Brazilian subjects had a much higher level of periodontitis. It appears that the predictive values of the PSR improve if the prevalence of periodontitis is low in a given population.

A potential weakness of this study is the use of dental students obtaining the PSRs. Dental students and general practitioners tend to use higher probing forces than periodontists [13], which could increase the prevalence of high PSR scores in relation to the periodontist's diagnosis. To counteract this effect, all examiners were extensively and successfully calibrated as described above. An inherent weakness in the calibration method employed was that interexaminer reliability between periodontist TB and other periodontists was not known since no other periodontist was available on site during the course of this study. Since conclusion of the study, we were able to test diagnostic reliability of periodontist TB with another periodontist, and noted similar reliability measures as those found between the student/dentist pairs and periodontist TB.

A concern by Khocht et al., that the PSR may underdiagnose periodontal conditions has been confirmed in this study, as there is a 0.9% chance of missing a pocket greater than 5 mm given the relatively low reproducibility of the PSR, even as it is performed by calibrated dental students checked by calibrated dentists. There is also the potential that the PSR will not detect periodontitis in patients who had successful periodontal treatment since it does not measure clinical attachment levels. However, in this patient population where few patients (<1%) received successful and sustained periodontal treatment, the PSR is a good screening tool for the absence of periodontal disease (97%), and sensitivity is on par or exceeds that of common medical screening tools such as mammograms (79% for breast cancer [14]) or colonoscopy (95% for colorectal cancers [15]).

Conclusion

Given its high predictive potential (81-93% for chronic periodontitis, gingivitis and periodontal health), the PSR is a useful screening instrument in patients with average systemic health and no prior significant periodontal treatment. It has also been concluded that the PSR can be used as screening instrument for periodontal long-term care of patients with no attachment loss, thus validating the recommendations by the American Dental Association [6].

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