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Original Research Article

Interest of periotest in the evaluation of the impact of bone and clinical attachment loss on tooth mobility in patients with periodontitis

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Abstract

Introduction: Tooth mobility remains a widely observed clinical sign in periodontitis. Its increase may indicate periodontal tissue destruction, namely clinical attachment loss associated with bone destruction.
Aims & Objective: To assess tooth mobility using the perotest and to correlate clinical attachment loss, alveolar bone loss with increased periotest values.
Materials and Methods: This is a cross-sectional, descriptive and analytical study carried out in patients with periodontitis over a period of 6 months. Each study participant underwent a periodontal clinical examination performed by a dental surgeon previously calibrated on the use of mobility indices, probing method and periotest. Dental mobility was assessed first subjectively with the Miller index and then objectively with the periotest. The periodontal variables were: O'leary plaque index (PI), Ainamo and Bay bleeding on probing index (BoP), pocket depth (PP), and clinical attachment loss (CAL).
Results: A total of 176 teeth were selected from 57 patients with periodontitis. The mean pocket depth was 2.78 ± 1.31 mm, attachment loss was 5.41 ± 1.74 mm, and the crown-to-root ratio was 1.81. A statistically significant correlation was found between tooth mobility, pocket depth, attachment loss, and crown-to-root ratio, with Pearson coefficients of 0.406, 0.472, and 0.652, respectively. Bone loss during periodontal disease has a significant impact on tooth mobility.
Conclusion: These results confirm the objectivity of the periotest in assessing tooth mobility in patients with periodontitis.

Keywords: Periodontitis, Tooth mobility, Periotest, Clinical attachment loss, Bone loss

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1. Introduction

Periodontal diseases are multifactorial infectious pathologies initiated by a dysbiotic microbiota.[1] They manifest clinically as gingival inflammation, progressive destruction of the attachment system, bone loss, tooth mobility, and ultimately, tooth loss.[2,3] Increased tooth mobility remains a widely observed clinical sign in periodontitis. In addition to discomfort due in particular to difficulty chewing, increased tooth mobility may indicate destruction of periodontal tissues, namely clinical attachment loss associated with bone destruction.[4] The assessment of tooth mobility is important in daily practice because it provides information on the long-term prognosis of teeth. Tooth mobility is assessed using different methods: the Miller method, which is subjective and consists of firmly holding the tooth between two metal instrument handles and mobilizing it in a vestibulolingual direction. However, it has limitations regarding the objective assessment of mobility.[4] The periotest method is an objective, reliable and reproducible method. It allows to evaluate the damping characteristics of the periodontium and indirectly, tooth mobility with an excitation pulse of approximately one millisecond.[5] According to Goellner 2013, the use of the Periotest can provide valuable information on quantitative metric tooth mobility in periodontally affected teeth.[6,7] Recent studies have investigated the influence of attachment loss and bone destruction on tooth mobility showing a significant correlation between the level of bone lysis (measured from the crown-root ratio) and tooth mobility (measured using a photogrammetric measurement

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technique).[6] Thus, the use of the periotest as a method for measuring tooth mobility could provide more objective and statistically significant results and thus serve as criteria for the assessment of periodontal conditions. The objective of this study was to assess tooth mobility using the periotest and to correlate clinical attachment loss, alveolar bone loss with increasing periotest values.

2. Materials and Methods

This was a prospective, cross-sectional, descriptive, and analytical study conducted in the Periodontology Department of the Institute of Odontology and Stomatology at Cheikh Anta DIOP University in Dakar, the Odontology Department of Aristide le Dantec Hospital, and the Gilbert Larroque Institute in Dakar. It was conducted over a 6-month period, from January to June 2019, in patients with periodontitis.

2.1. Inclusion criteria

Patients: in adult teeth, suffering from periodontitis diagnosed according to the new classification of periodontal diseases,[2,3] not presenting intercurrent pathologies or periodontal risk factors, having at least one central incisor, one lateral incisor, one canine, one premolar and one first molar in the maxilla and mandible.

2.2. Exclusion criteria

Patients: smokers, suffer from diabetes, or any other systemic disease that could constitute a risk factor for the progression of periodontitis; who have received periodontal and/or antibiotic treatment within 3 months prior to inclusion or anti-inflammatory treatment within 15 days prior to inclusion; who have received orthodontic treatment or who have a factor on the selected teeth other than loss of bone support that could cause increased tooth mobility: occlusal trauma, endodontic lesions, caries, non-carious lesions, enamel cracks, occlusal attrition, sensitivity to percussion, an inflammatory reaction, or a prosthetic restoration.

2.3. Periodontal assessment

Each patient who agreed to participate in the study underwent a clinical examination by a dental surgeon previously trained in the use of mobility indices, probing methods, and periotest. The periodontal assessment variables were: O'Leary plaque index (PI), Ainamo and Bay bleeding on probing index (BoP), pocket depth (PD), and clinical attachment loss (CAL) between [1-3 mm], [4-5 mm], [6-7 mm], [>7 mm].

2.4. Assessment of tooth mobility

The assessment of variables related to tooth mobility was performed first subjectively using the Miller index and then objectively using the periotest. The Miller method consists of holding the tooth firmly between two metal instrument handles and moving it in a vestibulolingual direction.[4] Tooth mobility is classified on a scale of 0 to 3:

1. Class 0 mobility: corresponds to natural movement; it is a physiological mobility that is less than 1 mm;
2. Class 1 mobility: greater than normal mobility but less than 1 mm.
3. Class 2 mobility: maximum mobility of 1 mm in the buccolingual direction.
4. Class 3 mobility: mobility of more than 1 mm in the buccolingual direction associated with axial movement.

Tooth mobility was recorded at a fixed point (center of the dental crown) using a periotest (Periotest M Robolab) placed perpendicularly at a distance of between 0.6 and 2 mm from the dental crown [6]. Three periotest value (PTV) measurements were taken at a time interval of 20 minutes (allowing the periodontium to return to its pre-test state). During each measurement, the retractable head of the instrument struck the tooth in a cycle of 16 strokes lasting approximately 4 seconds. The contact time on the tooth surface is measured by the instrument that calculates the value of tooth mobility. (**Figure 1**, **Figure 2**)

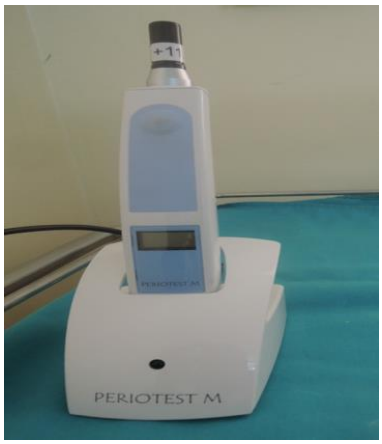

Figure 1: Periotest M

Figure 2: Measurement of mobility with the periotest. The recording of dental mobility was carried out at a fixed point (center of the dental crown) using a periotest (Periotest M Robolab) placed perpendicularly at a distance between 0.6 and 2 mm

Intra-examiner reproducibility was achieved with 10 subjects by repeating the measurements with the periotest 3 times in a row in the same individual (test-retest) at 48-hour intervals. A weighted Lin concordance coefficient for the 3 values measured during the test-retest procedures was

calculated and showed good concordance (r = 0.97). Indeed, a correspondence between the objective values recorded with the periotest and the degrees of mobility according to the Miller method was established (**Table 1**)

Table 1: Agreement between the Miller scale and the values recorded with periotest

Mobility Clinical indices	Degree of Mobility	Periotest measurements
Physiologique	0	-8 à +9
Horizontal < 1 mm	1	+10 à +19
Horizontal > 1 mm without vertical mobility	2	+ 20 à +29
Vertical	3	+30 à + 50

Crown-to-Root Ratio Assessment

The crown-to-root ratio (CRR) was calculated from digital periapical images taken of selected teeth using RadiAnt DICOM Viewer software (**Figure 2**, **Figure 3**).

Figure 3: Retroalveolar radiograph showing crown-root ratio measurements.[6]

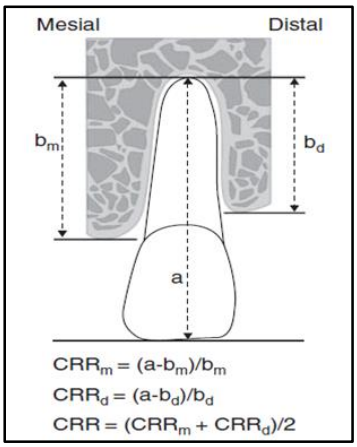

Figure 4: Crown root ratio calculations using software RadiAnt DICOM Viewer a = tooth length, bm = mesial edge, bd =distal edge, CRR = crown root ratio, CRRm = mésial crown root ratio, CRRd = distal crown root ratio.[6]

The study protocol was explained to all participants, and oral consent was obtained from the respondent.

Statistical Analysis, the collected data were analyzed using R software version 3.5.0. Descriptive statistics were calculated for all variables as frequencies and means. Correlations between periotest values and periodontal clinical variables were performed using the Pearson correlation test. Multiple logistic regression was performed to determine a correlation between the dependent variable (tooth mobility) and the independent variables (attachment loss and crown-to-root ratio).

3. Results

The study sample consisted of 57 patients with periodontitis. A total of 176 teeth were selected.

The mean age was 41.58 years ± 13.8. Most patients presented with tooth mobility (73.6%). The majority of patients presented with generalized periodontitis (80.7%) compared to 19.3% with localized periodontitis. Stage 4 and grade C generalized periodontitis was found in 52.65% of patients (**Table 2**). Plaque control was poor (PI = 70.76% ± 21.2). Gingival inflammation was present with a bleeding index on probing of 59.15% ± 25.54. At the sites examined, the mean pocket depths and attachment losses recorded were 2.78 mm ± 1.31 and 5.41 mm ± 1.74, respectively (**Table 3**).

Table 2: Distribution of the sample according to periodontal diagnosis.

Type of periodontitis	n (%)
Localized periodontitis stage 3 grade B	2 (3.50%
Localized periodontitis stage 3 grade C	9 (15.80%)
Generalized periodontitis stage 2 grade A	1 (1.75%)
Generalized periodontitis stage 2 grade C	2 (3.50%)
Generalized periodontitis stage 3 grade B	9 (15.80%)
Generalized periodontitis stage 3 grade C	4 (7.00%)
Generalized periodontitis stage 4 grade C	30 (52.65%)

Table 3: Sample distribution according to clinical data.

Periodontal variables	Mean ± SD	SE	Max	Min
IP (mean in %)	70.76 ± 21.2	2.8	100	20
BOP (mean in %)	59.15 ± 25.54	3.3	100	10
PP (mean in mm)	2.78 ± 1.31	0.17	6	1
PAC (mean in mm)	5.41 ± 1.74	0.23	12	2

PI= plaque index, BOP= bleeding on probing index, PP= pocket depth, PAC= attachment loss, SD= standard deviation, SE= standard error.

3.1. Characteristics related to tooth mobility

High periotest scores (+30 - +50) correspond to Miller grade III. The recorded tooth mobility values were slightly higher for the lower incisors, and the comparison of the values showed no statistically significant difference except between the incisors and the premolars (mean PTV incisors = 26.92 ± 11.71 - mean PTV premolars = 47.85 ± 4.3, p = 0.0048) (**Table 4**). A significant increase in mobility was noted for attachment losses between 4 and 7 mm. The crown-to-root ratio values were higher for the lower central incisors than for the upper central incisors, with a statistically significant difference (p = 0.043).

Table 4: Values of dental mobility measured with the periotest for each group of teeth.

Tooth Type	N	PTV (Mean±SD)
Upper Central Incisor	19	26.5± 8.42
Lower Central Incisor	92	28.9± 13.34
Upper Lateral Incisor	4	23.2± 3.74
Lower Lateral Incisor	54	24.7± 9.94
Upper Canine	1	41.8
Lower Canine	1	12.5
Upper Premolar	2	45.7±6.08
Lower Premolar	2	50
Lower Molar	1	28

PTV: tooth mobility value.

Tooth mobility was thus significantly correlated with pocket depth, attachment loss and crown-root ratio with a Pearson coefficient of p=0.406, p=0.472, p=0.652 respectively. There was no relationship between tooth mobility and plaque and bleeding index on probing. (**Table 5**).

Table 5: Pearson correlation coefficient between PTV scores and periodontal variables.

Variables	R	p
IP	0.237	0.075
BOP	0.248	0.061
PP	0.406	0.001
PAC	0.472	0.00024
CRR	0.652	3. 7 E-08

IP= indice de plaque, **BOP=** indice de saignement au sondage, **PP=** profondeur de poche, **PAC=** perte d'attache, SD= standard déviation, CRR= rapport couronne –racine, **R=** coefficient de Pearson, **p=** valeur de p est significative à p< 0,05.

The coefficient of determination R2 shows that 41.60% of the causes of tooth mobility are due to bone destruction. However, the correlation is weaker for pocket depth (PP) and attachment loss (AL). The PAC and CRR adjusted PP is statistically and significantly associated with PVT (Table VI). This is confirmed by the scatter plots of tooth mobility as a function of attachment loss and crown-root ratio (**Figure 5**).

Table 6: Linear regression coefficients using PTV as the dependent variable.

Variables	Coefficient	Coefficient SE	P	Adjusted R2
PP	3.33	1.011	0.001	15%
PAC	2.93	0.746	0.00024	20.80%
CRR	7.39	1.157	3.6^{E}-8	41.60%

PP= pocket depth, PAC= attachment loss, SD= standard deviation, CRR= crown-root ratio, p= p-value is significant at p□0.05, PI= plaque index, BOP= bleeding on probing index, PP= pocket depth, PAC= attachment loss, SD= standard deviation, CRR= crown-root ratio, R= Pearson coefficient, p= p-value is significant at p□0.05, adjusted R2 = coefficient of determination.

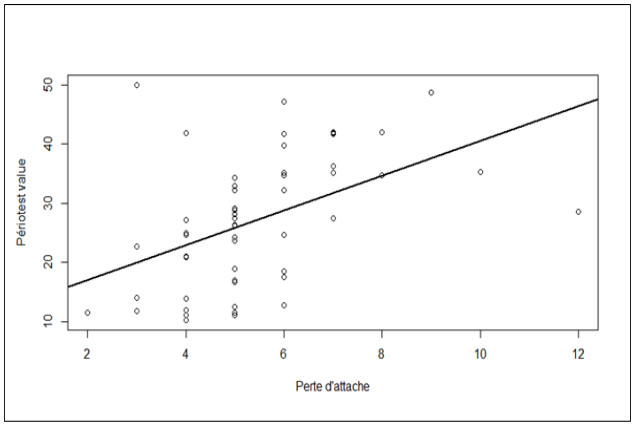

Figure 5: Scatter plot of tooth mobility versus attachment loss.

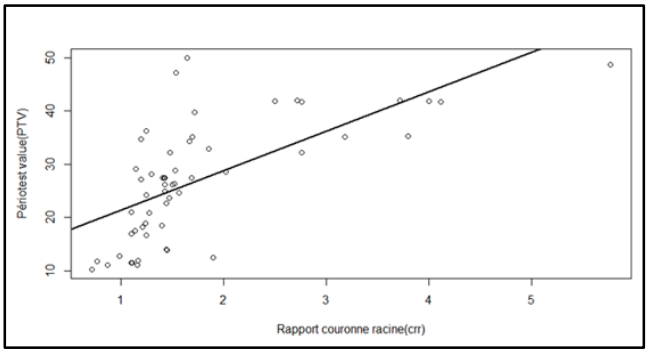

Figure 6: Scatter plot of tooth mobility as a function of crown-root ratio.

4. Discussion

The relationship between increased tooth mobility values measured with the periotest and the severity of attachment loss and bone destruction in patients with periodontitis has been the subject of several studies.

The periotest was used in our study to measure tooth mobility due to its ease of use in daily practice. Indeed, it is an objective and highly reproducible device for measuring tooth mobility.[8-10] The accuracy of its measurements has been

reported by Levander et al.[11] and Berthold et al.[8] However, the periotest has some limitations. Indeed, it has been reported that the highest reproducibility of the method is found for teeth with low to moderate mobility (Miller grade I, Miller grade II), while measurements of highly mobile teeth are less reproducible.[12,13]

In our study, the periodontal characteristics showing the severity of periodontitis: mean PP = 2.78 ± 1.31 mm with a maximum of 6 mm; mean PA = 5.41 ± 1.74 with a maximum of 12 mm; unfavorable crown/root ratio, were correlated with tooth mobility. This is consistent with the studies of Goellner et al[6] which indicates a correlation of tooth mobility measured with the periotest showing[7] an average attachment loss of about 4 mm with a maximum of up to 10 mm. Similarly, Singh et al.[14] showed a correlation between tooth mobility measured with the periotest and the average pocket depth and attachment loss which were 3.003 ± 0.104 mm and 3.908 ± 0.126 mm, respectively. Our sample size was 57 patients, which is close to the study of Mischra et al.[15] who included 50 patients. Whereas Goellner et al. [and Raslan et al.[16] included a smaller number of 20 patients in their studies.

The limitation of our study was the small number of canines, premolars and molars found in our sample. However, most studies that have focused on this area have only considered incisors and canines. Despite these limitations, the sample allowed comparison and correlation tests to be performed. Person's correlation coefficient showed a significant correlation between the variables pocket depth, attachment loss and crown-root ratio with respective Pearson coefficients of 0.406 p (=0.001); 0.472 p (=0.00024); 0.652 p (<0.05). No correlation was found between tooth mobility and plaque and bleeding index on probing. Our results are in agreement with those of Falgas et al.[17] as well as those of Singh et al.[14] A linear regression performed from the mean values of pocket depth, attachment loss and crown-root ratio confirmed the positive correlation between tooth mobility, attachment loss, pocket depth and alveolysis. The coefficient of determination R2 showed a weak correlation between the pocket depth variable and the values of tooth mobility. The scatter plot performed from attachment loss versus mobility values showed that the values are more randomly distributed around the regression line. The linear regression coefficient analysis is R = 2.93 p = 0.00024, which indicates the existence of a weak but nevertheless significant correlation between high values of tooth mobility and the severity of attachment loss. This result is consistent with the observations of Goellner et al.[6] The study of the scatter plot made from tooth mobility (PTV) and the crown-root ratio shows a narrow distribution around the regression line. Statistical analysis of these data reveals a coefficient of R = 7.39 p = 3.6E-8, indicating a statistically significant association between increased tooth mobility and alveolysis. These results corroborate the work of Goellner et al.[6,7]

However, the periotest has some limitations, partly related to its use in the posterior sectors (perpendicular position of the handpiece in relation to the surface of the crown), which explains the fact that most of the studies that have focused on this area have only taken into account incisors and canines. Similarly, its use is operator-dependent and the values recorded can only be considered reliable by a trained practitioner.

5. Conclusion

The results of our study showed that periodontitis severity parameters (PP, PA, CRR) influence the increase in the degree of tooth mobility measured by the periotest. They thus confirm the objectivity of the periotest in assessing tooth mobility. Thus, Periotest values can be used as an objective and fundamental criterion for assessing periodontal conditions. However, further studies are needed to validate these results.

6. Author Contributions

All authors contributed to the conduct of this work. All authors also declare that they have read and approved the final version of the manuscript.

7. Conflicts of Interest

The authors declare no conflicts of interest.

8. Source of Interest

None.

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