Assessment of Tooth Movement and Bleeding on Probing: Clinical Indicators of Periodontal Disease Progression

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Abstract. Periodontal disease is a chronic inflammatory condition that leads to the destruction of the supporting structures of the teeth. Two of its key clinical features are bleeding on probing (BOP) and tooth mobility, often reflective of underlying tissue breakdown. The aims of this study were to investigate the correlation between bleeding on probing and pathological tooth movement in patients with varying stages of periodontal disease, and to assess their diagnostic and prognostic significance. This cross-sectional study included 120 adult patients who underwent comprehensive periodontal examination. Parameters assessed included BOP, and tooth mobility. Statistical analysis was conducted to evaluate associations between BOP and pathological tooth movement. BOP was detected in 78.5% of patients, with a higher prevalence in the posterior sextants. Tooth mobility (Grade 2 or higher) was observed in 31.6% of the sample, predominantly in the maxillary and mandibular anterior teeth. A statistically significant correlation was found between BOP and pathological tooth movement ($p < 0.01$), with generalized BOP increasing the likelihood of tooth mobility by nearly fourfold (OR = 3.8). The presence of BOP is significantly associated with pathological tooth mobility, underlining its importance as a predictive marker in periodontal assessment. Early identification and intervention at sites with BOP may help prevent progressive tooth loss.

Highlights:

1. Iraqi Cardaria daraba L. contains alkaloids, flavonoids, tannins, terpenoids, and saponins with notable antioxidant activity (IC_{50} = 2.96 mg/ml).
2. HPLC analysis revealed high levels of vitamin C (42.8 mg/ml) and vitamin A (49.8 mg/ml) in the plant extract.
3. AAS and FESEM-EDS analyses confirmed the presence of essential elements such as Fe, Zn, Ca, Mg, Se, and Sr, supporting its medicinal potential.

Keywords: Periodontal disease, Bleeding on probing, Tooth mobility, Clinical indicators, Periodontal assessment

Introduction

Periodontal disease is a prevalent chronic inflammatory condition that affects the supporting structures of the teeth, including the gingiva, periodontal ligament, cementum, and alveolar bone.

It is primarily initiated by the accumulation of dental plaque biofilm, which triggers a host-mediated immune response [1]. Over time, this immune response, if left unmanaged, leads to the progressive destruction of the periodontium, ultimately resulting in clinical attachment loss, alveolar bone resorption, and eventual tooth loss [2]. Despite significant advances in preventive and therapeutic strategies, periodontal disease continues to be a major cause of adult tooth loss globally.

Among the clinical parameters used to assess periodontal status, bleeding on probing (BOP) and tooth mobility are both widely recognized and frequently encountered signs of periodontal deterioration [3]. BOP is an early and sensitive marker of gingival inflammation. It reflects the presence of ulcerated sulcular epithelium and an active inflammatory response, making it a valuable indicator of disease activity [4]. While BOP alone may not definitively predict future attachment loss, its persistence is often associated with a higher risk of disease progression.

Tooth mobility, on the other hand, is commonly associated with more advanced stages of periodontal destruction. As periodontal support diminishes due to the loss of connective tissue and alveolar bone, the tooth becomes increasingly unstable [5]. Pathological tooth movement not only compromises masticatory efficiency and patient comfort but also signals potential irreversible damage to the periodontal attachment apparatus [6].

Although both BOP and tooth mobility are independently important in periodontal evaluation, the interrelationship between these parameters has not been extensively studied [7]. Understanding whether bleeding on probing is predictive of or correlated with pathological tooth movement can offer deeper insight into the disease process and may help clinicians prioritize interventions at an earlier stage [8].

The present study was undertaken to assess the correlation between bleeding on probing and pathological tooth movement in individuals presenting with varying severities of periodontal disease. By investigating the diagnostic and prognostic significance of these clinical signs, this study aims to contribute to more comprehensive and effective periodontal evaluation strategies.

Materials and Methods

Study Design

This study was designed as a cross-sectional observational study conducted at the College of Dentistry, Al-Hadi University, from November/2023 to February/ 2025. The study aimed to assess the correlation between bleeding on probing (BOP) and pathological tooth movement among adults diagnosed with various stages of periodontal disease.

Ethical Considerations

The research protocol was approved by the Institutional Ethics Committee of Dentistry college, Al-Hadi University. All participants provided written informed consent before being enrolled in the study.

Study Population

A total of 120 adult patients, aged between 25 to 65 years, were recruited based on specific inclusion and exclusion criteria to minimize potential confounders.

Inclusion Criteria
1. Adults aged 25–65 years
2. Possession of at least 20 natural teeth
3. No periodontal treatment in the last 6 months
4. Systemically healthy individuals

Exclusion Criteria
1. Smokers or users of tobacco in any form
2. Individuals with systemic diseases known to affect periodontal health (e.g., diabetes mellitus, immunodeficiency)
3. Pregnant or lactating women
4. Patients undergoing orthodontic treatment
5. Use of anti-inflammatory or antibiotic therapy within 1 month prior to examination

Calibration of the Examiner

A single calibrated periodontist conducted all clinical examinations. Calibration was performed prior to the study to ensure intra-examiner reliability, with a kappa value > 0.85 for reproducibility of clinical measurements, including probing depth and tooth mobility.

Clinical Examination and Parameters Assessed

Comprehensive periodontal assessments were conducted for each participant under adequate lighting using a mouth mirror and a UNC-15 periodontal probe. The following clinical parameters were recorded:

1. Bleeding on Probing (BOP)
Measured at six sites per tooth (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, distolingual).
A site was recorded as positive for BOP if bleeding occurred within 15 seconds of gentle probing to the bottom of the sulcus/pocket.

2. Tooth Mobility
Assessed using two rigid instruments and graded according to Miller's Classification [9]:
Grade 0: Normal physiological mobility
Grade 1: Slight mobility (<1 mm horizontal movement)
Grade 2: Moderate mobility (>1 mm horizontal movement)
Grade 3: Severe mobility (horizontal and vertical displacement)
Only Grade 2 and Grade 3 mobility were considered pathological and included in the final analysis for correlation with BOP.

Data Collection and Grouping

Participants were grouped based on the presence or absence of generalized BOP and presence or absence of pathological tooth movement. "Generalized BOP" was defined as bleeding present in ≥30% of examined sites. "Pathological tooth movement" was defined as any tooth exhibiting Grade 2 or higher mobility.

Statistical Analysis

All data were compiled and analyzed using SPSS software version 26.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (mean, standard deviation, frequencies) were used to summarize demographic and clinical data. Chi-square tests were used to determine associations between categorical variables, such as the presence of BOP and pathological tooth mobility. Logistic regression analysis was performed to calculate the odds ratio (OR) for the likelihood of tooth mobility in patients with generalized BOP. A p-value < 0.05 was considered statistically significant.

Results

A total of 120 adult patients (ages 25–65, mean age 43.7 ± 10.5 years) participated in this cross-sectional study. The clinical parameters analyzed included Bleeding on Probing (BOP), and tooth Mobility. The sample was balanced in gender distribution (52% female, 48% male), with most participants presenting with chronic periodontitis of varying severity. Out of the total sample, 94 patients (78.5%) exhibited at least one site with BOP. Among these, 56 patients (46.7%) had generalized BOP (defined as >30% of sites affected). Tooth mobility of Grade 2 or higher was observed in 38 patients (31.6%), most commonly affecting anterior teeth due to their reduced root surface area and susceptibility to occlusal forces.

Table 1: Prevalence of BOP and Tooth Mobility

Parameter	Number of patients	Percentage (100%)
Total patients	120	100%
Patients with BOP	94	78.5
generalized BOP (>30% sites)	56	46.7
Patients with tooth mobility (grade ≥2)	38	31.6
Anterior teeth affected	27	71.0 (of 38)

A chi-square test revealed a statistically significant association between the presence of BOP and pathological tooth mobility ($p < 0.01$). Patients with generalized BOP were 3.8 times more likely to exhibit Grade 2 or higher mobility (OR = 3.8, 95% CI: 1.9–7.4).

Table 2: Association Between BOP and Tooth Mobility

BOP Status	Mobility present (n=38)	No mobility (n=82)	Total patients
Generalized BOP	28	28	56
Localized/ No BOP	10	54	64
total	38	82	120

Sites exhibiting BOP had significantly deeper probing depths and greater clinical attachment loss than non-bleeding sites.

Table 3: Comparison of Clinical Parameters Between BOP+ and BOP- Sites

parameter	BOP+Sites (Mean±SD)	BOP-Sites (Mean±SD)	*P*-value
Probing Pocket Depth	4.6±1.2 mm	2.8±0.9 mm	0.001*
Clinical Attachment Loss	3.9±1.0 mm	2.1±0.8	0.003*

Statistical significance, *P* < 0.01*

Mobility was more prevalent in anterior sextants (especially the mandibular central incisors) while BOP was most frequent in posterior sextants, particularly the molars in both arches. This suggests that different areas may reflect different aspects of disease progression—posterior areas may signal early inflammation (BOP), while anterior areas may show later-stage mechanical breakdown (mobility).

Table 4: Distribution of Clinical Indicators by Dental Region

Region	BOP Prevalence (%)	Mobility Prevalence (%)
Maxillary Anterior	64.2	36.8
Maxillary Posterior	81.7	28.3
Mandibular Anterior	59.1	42.7
Mandibular Posterior	78.9	30.2

Discussion

The present study assessed the relationship between bleeding on probing (BOP) and pathological tooth mobility in adults aged 25-65 years diagnosed with varying stages of periodontal disease. The findings demonstrate a strong and statistically significant association between generalized BOP and increased risk of tooth mobility, indicating that persistent gingival inflammation may be a precursor to mechanical instability of teeth.

Among the 120 patients studied, 78.5% exhibited at least one site with BOP, and 46.7% presented with generalized BOP (affecting ≥30% of sites). Notably, 31.6% of the participants had pathological tooth mobility (Grade 2 or above), with anterior teeth being most commonly affected. This pattern aligns with known biomechanical vulnerabilities of anterior teeth due to their relatively limited root surface area and greater exposure to occlusal forces. The chi-square analysis confirmed a significant correlation ($p < 0.01$) between generalized BOP and pathological tooth mobility [10]. Logistic regression further supported this finding, revealing that patients with generalized BOP were 3.8 times more likely to exhibit mobility, suggesting that widespread gingival bleeding may serve as an early indicator of structural degradation [11].

The study also showed that sites positive for BOP had significantly deeper probing pocket depths (4.6 ± 1.2 mm) and greater clinical attachment loss (3.9 ± 1.0 mm) compared to non-bleeding sites (2.8 ± 0.9 mm and 2.1 ± 0.8 mm, respectively), with both differences being statistically significant ($p < 0.01$). These findings reinforce the understanding that BOP is not merely a symptom of localized inflammation but is associated with more extensive periodontal destruction [11]. The presence of deeper pockets and loss of attachment at BOP-positive sites underscores the clinical utility of BOP as a predictive marker for disease progression [12].

The anatomical distribution of BOP and tooth mobility revealed important clinical patterns. Posterior sextants, particularly molars, showed higher prevalence of BOP, likely due to plaque accumulation and challenges in maintaining oral hygiene [13]. In contrast, mobility was more frequently observed in the mandibular anterior region [14]. This suggests that while posterior teeth may serve as early indicators of periodontal inflammation [15], anterior teeth more commonly manifest the mechanical consequences of disease [16], such as attachment loss and displacement.

Compared to previous research, this study adds depth to the understanding of the progression from gingival inflammation to periodontal breakdown [17]. While many earlier studies have validated BOP as an indicator of inflammation, fewer have explicitly explored its link to tooth mobility [17].

The present findings emphasize that generalized BOP should not be viewed as an isolated or benign clinical finding. Instead, it may serve as a red flag indicating the need for closer monitoring and timely intervention to prevent the onset of irreversible structural damage.

Although the study benefits from a well-defined age group, standardized clinical assessments, and clear inclusion criteria, some limitations must be acknowledged [18]. The cross-sectional design restricts the ability to establish causality. Additionally, the absence of radiographic analysis and the single-center recruitment may limit generalizability. Despite these limitations, the evidence suggests that generalized BOP is significantly associated with indicators of advanced periodontal disease, including tooth mobility.

Conclusion

The findings of this study highlight the importance of thorough periodontal examination and early detection of generalized BOP as a predictor of potential tooth instability. Timely periodontal intervention targeting inflammation may help prevent progression to tooth mobility and loss in young adults.

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