METHODS OF EVALUATION AND QUANTIFICATION OF DENTAL MOBILITY. SHORT REVIEW

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ABSTRACT
The registration of dental mobility is an important step in the periodontal clinical examination. The most common methods used in practice are: clinical assessment method and instrumental mobilometry. Dental mobility can be recorded by objective or subjective methods, the latter frequently leading to errors in clinical evaluation and research.

Key words: tooth mobility, dental pressure test, instrumental mobilometry, periotest

Introduction
Assessment of dental mobility is necessary for calculating the clinical index of the pathological mobility degree that is an important parameter for diagnosis, treatment planning and the follow-up of the long-term clinical evolution after the periodontal treatment.

The most common methods used in practice are: clinical assessment method and instrumental mobilometry [1, 2]. A recently introduced method is photometric measurements [3, 4]. Other methods of evaluation of dental mobility cited in the literature are the following: laser diode method [5], magnetic sensors method [6-8], the Doppler laser vibrometer method [9], holographic interferometry [10], and the tensometric mark method [11]. These methods have the following limitations: they are time consuming, costly or limited for use in vitro studies [12].

Clinical evaluation method
Clinicians often assess the status of a tooth by estimating its mobility. Because teeth are not ankylosed, or osseointegrated, as implants are, but they are suspended in the alveolar bone by a network of collagenous fibers, they exhibit a degree of physiological mobility. This is usually assessed as the amplitude of crown displacement resulting from the application of a defined force [13, 14].

Clinical procedures for registering dental mobility are:
- inspecting pathological mobility;
- palpation test;
- the percussion test;
- dental pressure test [15].

Most commonly, the degree of mobility is determined by means of two metallic instruments placed buccal and lingual/palatal, or by a finger and instrument [1, 16] (Figure 1).
Mobility grades, depending on the ease and extent of dental movement, are:
- Grade 0 = physiological mobility;
- Grade I = slightly higher than normal mobility, 0-2 mm in the horizontal bucco-lingually plane;
- Grade II = moderately higher than normal, ≥1 mm horizontal bucco-lingually and / or mesio-distal;
- Grade III = severe bucco-lingually and / or mesio-distal horizontal movement combined with vertical movement [1].

The technique of clinical evaluation is not an objective one [17].

Another device is the dento-periodontal mobilometer, a device that measures the dental movement of the frontal teeth in a bucco-lingual double direction, under the action of external forces, controllable in size and direction. The device is individually applied by means of an acrylate conformator, whereupon the comparator clock is activated with a dynamometer which develops constant stress forces, allowing the recording of dental movements at the level of hundreds of millimetres [15].

Another device recently used to assess dental mobility is Periotest (Siemens AG, Benssheim, Germany). It measures the oscillating character of the periodontium and, indirectly, the movements of the tooth through Periotes optical and acoustic values. The 'Periotest value' depends to some extent on tooth mobility, but mainly on the damping characteristics of the periodontium.

The use of Periotest should be avoided in the following cases: acute apical periodontitis, acute trauma (dislocation, root fracture, fracture of the alveolar process), and intraoperative implants in the healing stage during the first two or three months postoperatively. This device has a hand-like design and operates on the electromagnetic principle. Information on structural changes is obtained by measuring the elasticity and viscosity characteristics of the periodontium [21] (Figure 2).

With electric drive and electronic monitoring, the tip of the device percusses the tooth at a frequency of 16 times in 4 seconds. The Periotest measures the periodontal response to a defined percussion force (0.08 N) applied under electronic control. The tip is pressure sensitive and records the contact time with the test item. The principle of action is based on the visco - elastic properties of the healthy tooth that allows the percussion to decelerate in less than 1 millisecond [21] (Figure 3).
The device detects the tooth period necessary to regain its original position. Higher mobility teeth have a longer contact period and Periotest values are higher, while the teeth with reduced mobility have a shorter contact period which translates into smaller Periotest values. The amount of tooth mobility is displayed by a value called periotest value (PTV) ranging from $-8$ to $+50$, which can be correlated to $4^\circ$ of tooth mobility reported by Miller [23]. The PTV and its correlations to clinical mobility are given in Table 1.

To measure mobility, the maxillary and mandibular teeth should not be in contact, and the patient should slightly open the mouth to facilitate measurements in the lateral areas. To measure occlusal stress, the patient should be in the maximum intercuspal position.

During the measurement, the tip of the piece should not be in contact with the tooth, but there should be a distance of 0.6 to 2.5 mm. The piece should be adjusted to a position as close as possible to the horizontal ($\pm 25^\circ$) or right angled to the centre of the tooth to be examined [21] (Figure 4).

During the measurement, the tooth is squeezed 4 times per second. For each impulse that can be evaluated, the device emits a low, low tone tone. High tone tones indicate too much a deviation from the horizontal position and / or an incorrect tooth position. When the number of impulses is less than 4 (out of 16 possible), the measurement will not produce any result.

The value indicated by Periotest depends on the degree of mobility, mainly on the viscoelastic characteristics of the periodontium, being considered a biophysical parameter [24]. The device measures the response to a reproducible impact applied to the dental crown [25, 26].

It has been shown that there is a strong association between the Periotest values and the bone level, this device objectively indicating the degree of bone resorption [27].

![Figure 2. Periotest- M and Classic, Medizintechnik Gulden, Germany [22]](image2)

![Figure 3. Principle of action of Periotest, Medizintechnik Gulden, Germany [22]](image3)

![Figure 4. The correct position of the hand piece for the evaluation of dental mobility with the Periotest device [21]](image4)

<table>
<thead>
<tr>
<th>Periotest value</th>
<th>Clinical degree of tooth mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>$(-8) - (+9)$</td>
<td>0</td>
</tr>
<tr>
<td>$(+10) - (+19)$</td>
<td>I</td>
</tr>
<tr>
<td>$(+20) - (+29)$</td>
<td>II</td>
</tr>
<tr>
<td>$(+30) - (+50)$</td>
<td>III</td>
</tr>
</tbody>
</table>

Table 1. PTV and its correlation to clinical mobility
Studies have shown that Periotest mobility assessment method is a simple, objective, accurately and highly reproducible procedure, indicated for the clinical registration of dental mobility [25, 28-31]. The coefficient of variation of the measured values with this device has an average value of 4.3% [32].

Periotest has applicability for use in other areas of dental medicine, in addition to periodontology: traumatology [30, 33, 34], implantology [35, 36], prosthodontics [37], orthodontics [32, 38, 39].

**Method of photometric evaluation**

Photometry is an analytical method based on the photometric principle, which performs optical measurements (Figure 5). The system was introduced for research on in vivo [3] and in vitro [40] dental micro movements.

This technique is reproducible, useful for the three-dimensional evaluation of dento-periodontal response to axial or horizontal stresses, under different occlusal forces [40]. The system does not yet have a widespread use in dental practice, due to the cost price and the complex setup experimental model, made so far only for teeth in the frontal region [12].

The values of dental mobility obtained by the Periotest method and by the non-contact optical measurement method showed strong correlations, both before and after periodontal treatment. The most important correlation level was established for central incisors [12].

In the complex treatment of periodontal diseases, instrumental mobilometry is an objective criterion for assessing changes in dento-periodontal mobility, thus avoiding subjective clinical assessment of mobility.

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