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Objective Assessment of Tooth Mobility Using the Osstell Device

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Abstract

Background/Objectives: This study aimed to evaluate the applicability of Osstell for measuring natural tooth mobility using a custom-fabricated attachment and to assess its correlation with conventional methods. **Methods**: Sixteen patients (10 males, 6 females) with 94 permanent teeth were included. Mobility was assessed using the Miller Mobility Index, Periotest M, and Osstell Beacon. A custom titanium bracket bonded to the buccal surface enabled smartPeg attachment for Osstell measurements. Each tooth was measured twice, and mean values were recorded. Statistical analyses included Spearman's correlation, Cohen's kappa, and intraclass correlation coefficient (ICC). **Results**: Mean Periotest value was 12.70 ± 13.69, while mean Osstell values was 69.45 ± 19.37. Both devices showed excellent intra-examiner reliability (ICC >0.95). Periotest values demonstrated strong agreement with Miller classification (Kappa=0.763; p<0.001), whereas Osstell showed weak agreement (Kappa=0.094; p=0.048). A strong negative correlation was observed between Periotest and Osstell values (r = –0.865; p < 0.001). **Conclusions**: The Osstell device demonstrated reproducible measurements in natural teeth but lower sensitivity compared with Periotest. Despite weak agreement with Miller classification, its strong negative correlation with Periotest suggests potential as an adjunctive tool for objective mobility assessment. Larger studies including different tooth groups are required to confirm clinical applicability. This study is registered at ClinicalTrials.gov (NCT07188168).

Keywords: periodontal index; tooth mobility; resonance frequency analysis; periotest

1. Introduction

Tooth mobility refers to the physiological or pathological movement capability of a tooth within the alveolar bone.[1] Under normal conditions, teeth exhibit limited movement due to the presence of the periodontal ligament. However, factors such as trauma, periodontal diseases, occlusal trauma, or loss of supporting structures can increase this mobility.[2] Tooth mobility is a significant indicator of periodontal health and plays a crucial role in diagnosis, treatment planning, and monitoring treatment outcomes.[3] Tooth mobility is subjectively measured by Miller Mobility Index.[4] This traditional method involves applying bucco-lingual force to the tooth using the ends of two dental instruments and observing the amount of movement. Grading systems such as the Miller Mobility Index are often used (Grade 0–3). While simple and widely used, this method is subjective, and results may vary between clinicians. Therefore, in recent years, there has been a growing interest in developing more objective and quantitative measurement techniques.[1,5,6] The most commonly used techniques including Periotest, resonance frequency analysis.[7,8]

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The Periotest was first introduced in the late 1980s.[9] The Periotest is a diagnostic device designed to objectively evaluate the mobility of natural teeth and dental implants by quantifying the damping characteristics of the periodontium or peri-implant tissue. This is an electronic device that uses a tapping rod to assess the damping characteristics of the periodontium.[10] The Periotest device uses an electromagnetically controlled tapping rod (probe) to deliver a series of short, controlled mechanical impulses (typically 16 per measurement) to the surface of the tooth. The device then measures the contact time between the probe and the tooth. This contact time is influenced by the stiffness and damping properties of the surrounding tissues.[11] It provides numerical values (Periotest Values – PTV) and allows for a more standardized and reproducible measurement than manual methods.[12] Variations have been observed in mobility measurements performed with the Periotest device, not only between different examiners but also within the same examiner when assessing different regions. These discrepancies may be attributed to factors such as the angle of application and the necessity of maintaining a specific distance between the device and the tooth during measurement.[13]

Originally developed for implant stability evaluation, the Osstell device measures the resonance frequency of a transducer attached to a structure. It outputs ISQ (Implant Stability Quotient) values.[14] Resonance frequency analysis (RFA) has shown promise as a highly reliable, reproducible, and objective method, particularly because of its established reliability in implantology.[15] Although numerous studies have demonstrated a linear correlation between Periotest and RFA measurements on dental implants,[10,16] comparative analyses have also indicated that Osstell may provide more sensitive and precise measurements than that of Periotest.[11,17] However, there are no studies for its routine use of Osstell device in natural teeth. In this trial, it is hypothesized that mobility values obtained from natural teeth using the Osstell device—adapted with a specifically designed attachment—will demonstrate a statistically significant correlation with those obtained through established methods such as the Periotest and the Miller index. Accordingly, the aim of this study is to investigate the applicability of the Osstell device for assessing the mobility of natural teeth having different mobility grades and to evaluate the correlation between its measurements and those derived from conventional clinical mobility assessment methods.

2. Materials and Methods

This study was conducted at the Department of Oral and Maxillofacial Surgery, Faculty of Dentistry, xxxx University. The procedures planned for each eligible participant were explained in detail, and informed consent forms were obtained and signed by all patients. The study was carried out under the supervision of a single clinician. The entire study schedule and all relevant details were clearly communicated to the patients. Ethical approval for this study was obtained from the Ethics Committee with the protocol number 2022/35. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

Patient Selection

A total of 16 patients, including 10 males and 6 females, were selected for the study, and mobility measurements were performed on 94 permanent teeth. These teeth exhibited varying degrees of mobility, which allowed us to assess the compatibility and accuracy of the device across a broad spectrum of mobility grades.

Participants were selected according to the following inclusion and exclusion criteria to ensure consistency and reliability in the assessment of tooth mobility:

Inclusion Criteria:

- Individuals aged between 18 and 45 years.
- Systemically healthy individuals
- Teeth which they have intact periodontium or treated because of periodontal disease.

Exclusion Criteria:

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- History of psychiatric or neurological disorders.
- Impaired muscle coordination or neuromuscular dysfunction.
- Patients undergoing orthodontic treatment or with recent dental trauma affecting tooth stability.
- Presence of parafunctional habits such as bruxism (teeth grinding) or clenching.
- Presence of tooth pathologies such as endodontic or root resorption.

Mobility Measurement

All measurements were performed twice on each tooth by the same calibrated investigator to ensure consistency and eliminate inter-examiner variability. The repeated measurements were carried out under identical conditions for each assessment method (Miller mobility grading, Periotest M, and Osstell Beacon). To evaluate the intra-examiner reliability, the agreement of the two consecutive measurements was assessed using appropriate statistical methods. High intra-examiner agreement was considered indicative of the measurement reliability and reproducibility within the study.

Miller Mobility Measurement

The degree of tooth mobility was assessed by a single clinician according to the Miller Mobility Classification. This evaluation was performed by subjectively observing bucco-lingual movement of the tooth with the help of two dental instruments (Figure 1).

Miller Mobility Classification:

- Grade 0 (Physiological): Physiological mobility. No bone loss; probing depth approximately 2–3 mm.
- Grade I: Slight mobility; tooth moves ≤1 mm horizontally (bucco-lingual direction)
- Grade II: Moderate mobility; tooth moves >1 mm but ≤2 mm horizontally.
- Grade III: Severe mobility; tooth moves >2 mm horizontally and/or shows vertical mobility (i.e., depressible in the socket).[4]

Figure 1. Clinical assessment of tooth mobility using the Miller classification. Tooth mobility is evaluated by applying pressure with two instrument handles on the labial and lingual surfaces of a mandibular anterior tooth.

Periotest Device Measurement:

Measurement Protocol

The device was calibrated before each session. The target tooth was free of plaque, saliva, and blood. The Periotest probe was positioned perpendicular (90°) to the long axis of the tooth. It was held at a distance of approximately 1–2 mm from the buccal surface, without making contact (Figure 2). Two separate measurements are taken from each tooth. The mean value of these two readings is recorded as the tooth's PTV.[18]

Interpretation of Periotest Values[19]

PTV Range

- 8 to +9: clinically firm teeth

+ 10 to + 19: palpable mobility

+ 20 to + 29: visible mobility

+ 30 to + 50: severe mobility under the pressure of lip or tongue.

Figure 2. Objective measurement of tooth mobility using the Periotest device, applied to a mandibular anterior tooth.

Resonance Frequency Analysis

To assess tooth stability, RFA was performed using the Osstell Beacon device (Osstell, AB, Gothenburg, Sweden).

A custom-fabricated titanium bracket was used to accommodate the smartPeg and ensure standardized placement on each tooth. The bracket-like apparatus was carefully aligned with the long axis of the tooth and positioned apically. (Figure 3a)

Bracket specifications;

- Raw material: Medical-grade titanium, precision-machined using CNC (Computer Numerical Control) technology.
- Design: Cylindrical base with a centrally located, threaded slot for smartPeg insertion

SmartPeg thread slot;

- Internally threaded to enable clockwise insertion of the smartPeg (Figs 3b and 3c)
- Thread type: micro-thread,
- Tapered, centred aperture
- Diameter: approximately 1.2–1.5 mm

Tooth contact surface;

- Flat base designed to conform to the buccal surface of the tooth
- Smooth texture with micro-mechanical retention properties
- Suitable for adhesive fixation or direct contact application (Figure 3a).

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Figure 3. The titanium bracket, developed for measuring tooth mobility with the Osstell device, are shown. (a); cylindrical component with a flat surface indicated by a blue elliptical ring, designed to be bonded to the tooth. (b); external view of the Smartpeg seated within the cylindrical component. (c); internal view of the Smartpeg engagement within the cylindrical component.

Osstell Beacon Measurement Protocol

The apparatus was placed on the buccal surface of the respective tooth using flowable composite (Figure 4). Care was taken to ensure that the slot of the bracket designated for a smartPeg placement was oriented toward the root. Subsequently, the smartPeg was positioned in alignment with the root and torqued into place (Figure 5). After the smartPeg installation, two measurements were taken from different directions. The mean of the two readings was recorded as the final RFA value for each tooth. The Osstell Beacon was operated at a 2–5 mm distance, held perpendicular (90°) to the smartPeg without making contact. In this approach, the unit of measurement is the Implant Stability Quotient (ISQ), which is derived from resonance frequency analysis and ranges from 0 to 100, with higher values indicating greater stiffness at the implant–bone interface.[20]

A study indicates that an insertion torque of at least 30 Ncm is generally necessary to ensure the success of immediately loaded implants in edentulous patients. Conversely, insertion torque values below 20 Ncm have been linked to a greater likelihood of implant failure under immediate loading conditions.[21] Therefore, the recommended insertion torque is a value of ≥30 Ncm with an ISQ of >60.[22,23] Based on the recommended threshold of an insertion torque corresponding to an ISQ value above 60, the ISQ measurements obtained from the teeth in this study were categorized as follows: values below 60 were considered poor, values between 60 and 69 were classified as moderate, and values above 69 were regarded as good".[24]

Figure 4. Bonding of the titanium bracket to the tooth and light polymerization.

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Figure 5. Determination of tooth stability using the Osstell device. Note that the intraoral placement of the Smartpeg is aligned parallel to the root axis.

Statistical Analysis

The normality of the data distribution was tested using the Shapiro-Wilk test. The relationships between numerical variables were evaluated using Spearman's correlation coefficient. To assess the agreement between mobility classes and the Periotest and Osstell groups, Cohen's Kappa statistic was employed. The Kappa coefficient was interpreted as follows: values <0.00 indicated "poor agreement," 0.00–0.20 "slight agreement," 0.21–0.40 "fair agreement," 0.41–0.60 "moderate agreement," 0.61–0.80 "substantial agreement," and 0.81–1.00 "almost perfect agreement." The reliability of stability scores obtained from the Periotest and Osstell devices was evaluated using the Intraclass Correlation Coefficient (ICC). To determine inter-device agreement, ICC values were calculated based on a two-way mixed-effects model using the single measurement (average measure) approach. ICC values ≥0.75 were considered to indicate satisfactory reliability. All statistical analyses were performed using SPSS (Statistical Package for the Social Sciences), with a significance level set at 5% ($p<0.05$).

3. Results

A total of 16 patients and 94 teeth were included in the study; of these, 62.5% were male (n=10) and the remaining 37.5% were female (n=6). In the assessment of tooth stability using the Periotest device, the overall mean was 12.70 ± 13.69 (median: 8.25; min–max: –2.75–50). According to resonance frequency analysis performed with the Osstell device, the overall mean was 69.45 ± 19.37 (median: 77; min–max: 20 to 90). The most frequently evaluated regions included tooth #41 (11.7%) and teeth #11, #12, #21, #31, and #32 (each 9.6%), while the least frequent were tooth #44 (1.1%) and tooth #34 (2.1%) (Table 1).

Table 1. Demographic profile and tooth distribution of participants.

	n (%)
Male	10 (62.5)
Female	6 (37.5)
Tooth#	
11	9 (9.6)
12	9 (9.6)
13	7 (7.4)
21	9 (9.6)

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22	8 (8.5)
23	7 (7.4)
31	9 (9.6)
32	9 (9.6)
33	3 (3.2)
34	2 (2.1)
41	11 (11.7)
42	7 (7.4)
43	3 (3.2)
44	1 (1.1)

SD: Standard deviation. M: median. n (total)=94. #: tooth numbering based on World Dental Federation (FDI).

The agreement between two consecutive measurements obtained with the Periotest and Osstell devices was evaluated. For the Periotest, the mean value of the first measurement was 12.63 ± 13.75 (median: 7.80; min–max: –2.90 to +50), while the mean of the second measurement was 12.77 ± 13.70 (median: 8.45; min–max: –2.60 to 50). The reliability between the two measurements was statistically significant, with an ICC of 0.996 (95% CI: 0.994–0.997; p<0.001). For the Osstell device, the mean value of the first test was 69.04 ± 19.61 (median: 77; min–max: 20 to 90), and the second test yielded a mean of 69.86 ± 19.18 (median: 77; min–max: 20 to 90). The ICC value calculated between the two measurements was 0.998 (95% CI: 0.997–0.999), which was also statistically significant (p<0.001). For both devices, ICC values ≥0.95 indicate that the two measurements demonstrated an almost perfect level of reliability. (Table 2)

Table 2. Agreements between the first and second measurements obtained by Periotest and Osstell devices.

	First measurement mean±SD / M [min-max]	**Second measurement** mean±SD / M [min-max]	**ICC** (95%CI)	**p**
Periotest	12.63 ± 13.75 / 7.8 [−2.9 to +50]	12.77 ± 13.7 / 8.45 [−2.6 to +50]	0.996 (0.994-0.997)	**<0.001**
Osstell (Ncm)	69.04 ± 19.61 / 77 [20–90]	69.86 ± 19.18 / 77 [20–90]	0.998 (0.997-0.999)	**<0.001**

M: median. CI: coefficient interval. ICC: intraclass correlation coefficient. p-value reflects the statistical significance of the ICC coefficient. Ncm: newton/centimeter.

The agreement between measurements obtained with the Periotest and Osstell devices across Miller classes was evaluated. Periotest measurements were recorded as follows: 1.86 ± 2.84 (median: 1.78; min–max: –2.75–8.05) for class 0, 11.94 ± 5.16 (median: 11.75; min–max: 1.75–20.7) for class 1, 23.21 ± 5.61 (median: 24.5; min–max: 12.95–34.4) for class 2, and 41.71 ± 7.50 (median: 38.10; min–max: 32.65–50) for class 3. The overall mean was 12.70 ± 13.69 (median: 8.25; min–max: –2.75–50). Osstell measurements were determined as 82.04 ± 4.97 (median: 80; min–max: 74–90) for class 0, 73.50 ± 7.28 (median: 76.25; min–max: 60.5–88.5) for class 1, 59.46 ± 11.66 (median: 61; min–max: 32.5–76) for class 2, and 24.45 ± 6.08 (median: 23; min–max: 20–42) for class 3. The overall mean was calculated as 69.45 ± 19.37 (median: 77; min–max: 20–90). Intraclass correlation coefficient analyses performed to assess the reliability between the two devices revealed ICC values of 0.002 for class 0, 0.015 for class 1, 0.055

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for class 2, 0.115 for class 3. These findings indicate that the consistency between measurements obtained at different time points was very low, and the reliability remained at a poor level (Table 3).

Table 3. ICC analysis of Periotest and Osstell values by Miller classification.

Miller Class	**0** Mean±SD / M [min-max]	**I** Mean±SD / M [min-max]	**II** Mean±SD / M [min-max]	**III** Mean±SD / M [min-max]
Periotest	1.86 ± 2.84/ 1.78 [−2.75–8.05]	11.94 ± 5.16/ 11.75 [1.75–20.7]	23.21 ± 5.61/ 24.5 [12.95–34.4]	41.71 ± 7.50/ 38.10 [32.65–50]
Osstell	82.04 ± 4.97/ 80 [74–90]	73.50 ± 7.28/ 76.25 [60.5–88.5]	59.46 ± 11.66/ 61 [32.5–76]	24.45 ± 6.08/ 23 [20–42]
ICC	0.002 (0.001-0.008)	0.015 (0.012-0.018)	0.055 (0.032-0.166)	0.115 (0.037-0.268)
p	0.998	0.999	0.960	0.936

M:median. ICC: intraclass correlation coefficient. p-value reflects the statistical significance of the ICC coefficient.

Periotest and Osstell measurement values were significantly associated with the Miller mobility classification. In the distribution according to Periotest groups, all cases (100%) within the low range of –8 to +9 corresponded to Miller Class 0 mobility. In the range of +10 to +19, 63.3% of cases were classified as Class I and 23.1% as Class II. Within the +20 to +29 range, 69.2% of cases were classified as Class II, while all cases (100%) within the +30 to +50 range corresponded to Class III mobility. The mean PTVs by mobility class were as follows: 1.86 ± 2.84 for Class 0, 11.94 ± 5.16 for Class I, 23.21 ± 5.61 for Class II, and 41.71 ± 7.50 for Class III. A high level of agreement was observed between the PTVs and the Miller classes (Kappa=0.763; 95% CI: 0.655–0.871; p<0.001). (Table 4)

Table 4. Correlation between Periotest and Osstell values according to Miller classification.

	Miller Mobility Classes					
	Class 0 n (%)	Class I n (%)	Class II n (%)	Class III n (%)	κ (95%CI)	**p**
Periotest Scale						
-8 to 9	40 (100.0)	9 (30.0)	0 (0.0)	0 (0.0)		
10 to 19	0 (0.0)	19 (63.3)	3 (23.1)	0 (0.0)	0.763(0.655-0.871)	**<0.001**
20 to 29	0 (0.0)	2 (6.7)	9 (69.2)	0 (0.0)		
30 to 50	0 (0.0)	0 (0.0)	1 (7.7)	11 (100.0)		
PTV						
meant±SD / M [min-max]	1.86 ± 2.84 / 1.78 [–2.75 – 8.05]	11.94 ± 5.16 / 11.75 [1.75 – 20.70]	23.21 ± 5.61 / 24.50 [12.95 – 34.40]	41.71 ± 7.50/ 38.10 [32.65–50]		

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%95 CI	0.96 – 2.77	10.02 – 13.87	19.82 – 26.60	36.68 –46.75		
Osstell Scale						
<60	0 (0.0)	0 (0.0)	5 (38.5)	11 (100.0)	0.094 (0.089-0.099)	**0.048**
60 to 69	0 (0.0)	12 (40.0)	6 (46.2)	0 (0.0)		
>69	40 (100.0)	18 (60.0)	2 (15.4)	0 (0.0)		
RFA						
meant±SD / M [min-max]	82.04 ± 4.97 / 80 [74–90]	73.50 ± 7.28 / 76.25 [60.50 – 88.50]	59.46 ± 11.66 / 61 [32.50 – 76]	24.45 ± 6.08/ 23 [20–42]		
%95 CI	80.45 – 83.63	70.78 – 76.22	52.42 – 66.50	20.37 –28.54		

κ coefficient was derived from Cohen's Kappa statistic, *M: median. CI: coefficient interval. RFA: resonance frequency analysis, PTV: periotest value.*

When Osstell values were examined, all cases with values <60 demonstrated Class II or Class III mobility, while 100% of cases with values >69 corresponded to Class 0 mobility. The mean Osstell values by mobility class were calculated as 82.04 ± 4.97 for Class 0, 73.50 ± 7.28 for Class I, 59.46 ± 11.66 for Class II, and 24.45 ± 6.08 for Class III. However, the level of agreement between Osstell measurements and the Miller classification was low, with Kappa=0.094 (95% CI: 0.089–0.099; p=0.048), indicating a statistically significant but clinically weak relationship. (Table 4)

The agreement between the Osstell and Periotest classifications was evaluated using Cohen's kappa coefficient. The analysis revealed a kappa value of 0.088 (95% CI: 0.000–0.194), which was statistically significant (p = 0.045). However, the obtained kappa coefficient indicated a "poor" level of agreement. This finding suggests that Osstell and Periotest measurements operate largely independently from each other in terms of classification (Table 5).

Table 5. Correlations between Periotest and Osstell values.

Ostell scale	**-8 to 9** n (%)	**10 to 19** n (%)	**20 to 29** n (%)	**30 to 50** n (%)	**Overall** n (%)	κ (95%CI)	p
<60	0 (0,0)	0 (0,0)	4 (36,4)	12 (100,0)	16 (17,0)	0,088 (0-0,194)	**0,045**
60 to 69	0 (0,0)	12 (54,5)	6 (54,5)	0 (0,0)	18 (19,1)		
>69	49 (100,0)	10 (45,5)	1 (9,1)	0 (0,0)	60 (63,8)		
Overall	49 (100,0)	22 (100,0)	11 (100,0)	12 (100,0)	94 (100,0)		

κ coefficient was derived from Cohen's Kappa statistic. *M: median, CI: coefficient interval.*

"A strong positive and statistically significant correlation was observed between mobility classes and Periotest values in cases with an Osstell value below 60 (r=0.777; p<0.001). In cases with an Osstell value between 60–69, a positive and statistically significant correlation of moderate strength was found between mobility classes and Periotest values (r=0.477; p=0.045). (Graphic 1) Similarly, in cases with an Osstell value above 69, a strong positive and statistically significant correlation was observed between mobility classes and Periotest values (r=0.725; p<0.001). And also, a very strong and statistically significant negative correlation was observed between Osstell and Periotest values (r = –

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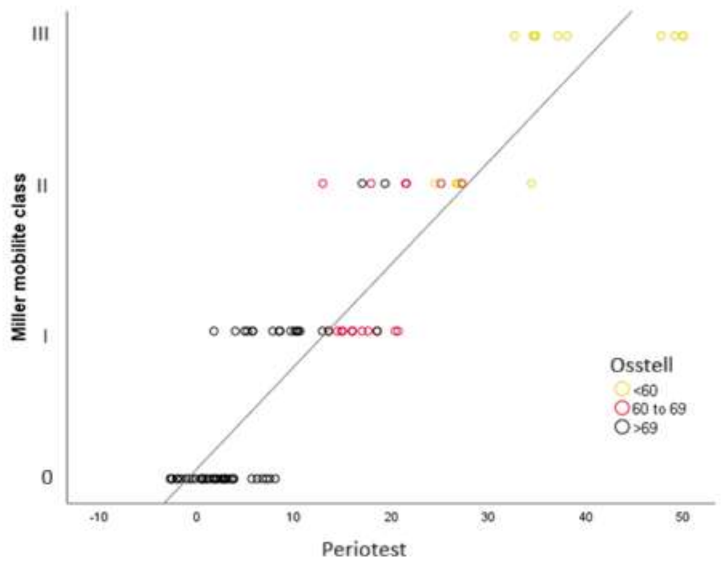
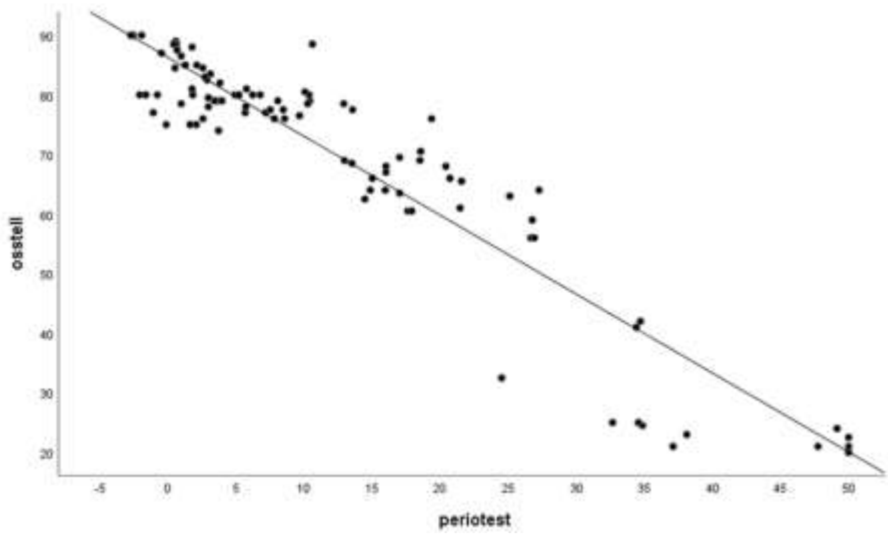
0.865; p < 0.001). The scatter plot depicting the relationship between the two variables is presented in Graphic 2."



Graph 1. Scatter plot of Miller, Periotest and Osstell values.



Graph 2. Scatter plot of Osstell and Periotest values.

4. Discussion

Tooth mobility is extremely important in determining the prognosis of teeth. The movement of a tooth within its socket may be pathological due to periodontal diseases, trauma, apical pathologies, root fractures, jaw cysts, and tumours, or it may be observed due to physiological reasons.[1] There is a distinction between the physiological limits of mobility and pathological mobility. The classification of tooth mobility in a way that distinguishes between these conditions is part of the diagnosis.[25] In clinical practice, mobility is most easily and rapidly determined using the subjective method known as Miller's Mobility Index. In this method, physiological mobility is indicated as 0, while values above this may point to certain pathologies.[4] However, the Miller classification is subjective and may vary from person to person. This may complicate diagnostic and prognostic decision-making, particularly in borderline cases. For this reason, the Periotest device, which provides objective measurements of mobility, has gained widespread use. Numerous studies have reported that Periotest can be utilized in periodontology, implantology, orthodontics, and traumatology.[13,24,26,27] These studies indicate that in addition to measuring mobility in both horizontal and vertical directions, Periotest provides reproducible results.[28–30] Periotest is based on software that converts the contact time between the tooth and the instrument into a numerical value, using a series of impacts at a speed of 0.2 m/s with a force of 8 g. This feature makes Periotest readings susceptible to changes in the fluid resistance of periodontal tissues.[31] Other studies have also reported that stabilizing devices may be required during Periotest measurement in order to reduce mobility.[32,33] Since the Periotest method may present certain difficulties in evaluating the condition of periodontal tissues and reaching a conclusion, it has also been used to measure implant stability.[34,35] Consequently, laser systems, intraoral scanners, or contact-free vibration devices have been proposed for measuring the viscosity, elastic modulus, and frequency of periodontal tissues.[1] In our study, an apparatus was developed to which a smartpeg could be screwed, attached with composite material to the buccal surfaces of permanent human teeth with varying mobility values. Using this setup, the mobility of the teeth was evaluated with the Osstell device. In this respect, this pilot application represents the first study in the literature in which the resonance frequency analysis (RFA) of teeth was compared with commonly used subjective (Miller) and objective (Periotest) methods, and their agreement was assessed.

Resonance frequency analysis can be performed with the Osstell device. Until now, this method has been used to measure implant stability. RFA allows the determination of the stiffness or degree of displacement between the implant and bone. The information obtained is expressed as the ISQ, which ranges from 1 to 100.[36,37] In the RFA method, a “smartpeg” sensor is attached to the implant, and the probe of the device is held close to the sensor in the bucco-lingual and mesiodistal directions during the emission of electromagnetic pulses. At the end of this process, the resonance frequency values are automatically converted into the ISQ scale and displayed on the device screen. ISQ values range from 1 to 100, with higher ISQ values indicating greater implant stability.[38] According to more than 700 references, ISQ >70 represents “high stability,” ISQ between 60 and 69 represents “moderate stability,” and ISQ <60 represents “low stability”.[24] When combined with other diagnostic tools such as radiography and ultrasonography, RFA provides a comprehensive assessment of both the mechanical and biological aspects of implant integration.[39]

Some researchers have stated that Periotest is more reliable in intraoperative measurements.[40] In contrast, Meredith et al. reported that Periotest has lower reproducibility and sensitivity.[41] Furthermore, in one implant study, RFA was reported to provide more accurate results in terms of sensitivity and specificity compared with Periotest.[24,26] From a practical perspective, the Periotest device is more efficient in terms of cost and ease of use, as it does not require any additional apparatus or preparation. However, adjusting the distance between the device and the tooth, as well as stabilizing and positioning the probe during measurement, is of great importance.[17,24] Deviations at this stage may reduce the reliability of measurements. In our study, a statistically significant agreement was found between consecutive measurements obtained using Periotest and Osstell. This indicates that mobility measurements performed with both devices are reproducible and reliable. Nevertheless, it should be noted that all measurements were carried out on anterior and premolar teeth, which greatly facilitated the positioning of both devices.

Miller’s mobility index is a subjective evaluation method in which mobility is classified into four categories ranging from 0 to 3. “0” indicates physiological mobility, meaning no detectable lateral movement of the teeth.[4] As the numerical value increases, the degree of tooth movement within the socket increases. Widening of the periodontal ligament space leads to increased lateral and vertical movement. In the Miller system, mobility is detected by grasping the tooth between the handles of two instruments and moving it laterally.[3] In Periotest measurements, the probe is held close to the tooth, delivering consecutive taps, and the return time of these impacts is converted into a numerical value that reflects mobility. Periotest values range from −8 to +50, with more positive values indicating greater mobility.[11] In resonance frequency analysis, lower values indicate reduced stability. In teeth classified according to Miller, agreement between mean Periotest and Osstell values was found in the Miller 0 and I groups, but this agreement deteriorated as mobility increased. This

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may explain why Periotest and Osstell devices are recommended for use in the different areas, such as the measurement of implant stability or natural tooth mobility. According to the manufacturer's instructions, Periotest values between –8 and +9 correspond to Miller 0, values between +10 and +19 correspond to Miller I, values between +20 and +29 correspond to Miller II, and values between +30 and +50 correspond to Miller III [42]. For Osstell, ISQ values <60 represent low stability, 60–69 represent moderate stability, and ≥70 represent high stability.[43] Although such a comparison is theoretical and not based on solid foundations, the Miller classification, Periotest, and Osstell groups were found to be compatible. However, this compatibility was higher for Periotest values. A statistically significant but weak agreement was found between Osstell and Periotest values. Among the 40 teeth with Osstell values ≥70, Periotest values ranged between –8 and +9, indicating that these teeth were within the physiological mobility range. However, in 11 teeth with the same Osstell value, Periotest values ranged between +10 and +29. This explains the weak agreement observed between Periotest and Osstell values in natural teeth. It should be remembered that this comparison was based on the Miller mobility classification, which is a subjective method. Since the Periotest scale adapted to Miller's classification may not be universally accepted, Osstell values may lead to incomplete scientific interpretations. Previous studies have shown that Periotest measurements may not be a valid parameter for assessing periodontal damage in teeth with different periodontal conditions, and histological studies are needed for this purpose.[44] This is because the damping characteristics of each tooth are unique and may vary according to age and sex.[45]

In measurements performed on teeth with different levels of mobility, a strong negative correlation was observed between Periotest and Osstell values, meaning that as Periotest values increased, Osstell values decreased. This finding is clinically important for interpreting stability values and may indicate that both systems function with a high level of accuracy at the case level. However, the correlation and reliability between these devices, which are primarily designed for implant stability, remain controversial.[24] Some studies have reported a strong correlation, while others have found no correlation.[46,47]

This study represents a pioneering attempt to evaluate tooth mobility using the Osstell device in natural teeth. However, it has certain limitations, such as including only anterior teeth, excluding molars, having a small sample size, and requiring the attachment of a fabricated part to the teeth for measurement. Moreover, the need to bond the manufactured component to the teeth for measurement is among its major disadvantages.

5. Conclusions

The mobility measurements of natural teeth performed with the Osstell device were found to be less sensitive and less reliable compared with those performed with Periotest. Nevertheless, a strong correlation was observed, suggesting that Osstell may be used as an alternative to Periotest in natural teeth. Considering the reliability issues in numerous studies conducted with Periotest on natural teeth and implants, this result may be interpreted in the opposite way. Therefore, further prognostic studies with larger sample sizes and including teeth with varying levels of mobility in both anterior and posterior regions are required before definitive conclusions and clinical recommendations can be made.

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Abbreviations

The following abbreviations are used in this manuscript:

ICC	Intraclass correlation coefficient
ISQ	Implant stability quotient
PTV	Periotest value
RFA	Resonance frequency analysis

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