

An evaluation of *TimPlant* using *Osstell*: A device for non-invasive assessment of dental implants stability

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Abstract

Aims: The aim of this study was to assess the clinical stability of dental implants (*TimPlant*; OR-VIT, Bologna, Italy) for restoring partially edentulous patients—Kennedy class I and II—using a resonance frequency device. **Methods:** One hundred and five *TimPlants* placed to support prostheses in the mouths of 34 partially edentulous patients were assessed using a resonance frequency device, *Osstell* (*Osstell*, Gothenburg, Sweden), with a type 4 smartpeg. The implants were assessed immediately after placement and at six-month intervals during the first or second year after implant loading (function). **Results:** The implant stability quotient values for the implants were between 59 and 90. These were optimal values for implant stability compared with previous similar studies. **Conclusions:** Data recorded with *Osstell* provide clinicians with useful information about the bone/implant interface at every stage of the treatment with dental implants. The determination of the resonance frequency of a vibrating structure is the most important parameter in assessing the quality of the bone/implant interface.

Key Words: Dental Implants, Stability, Assessment, *Osstell*

Introduction

Because tooth implantation influences the treatment plan in traditional prosthodontics, implant stability is the key parameter in deciding the optimal moment for loading and evaluating functional longevity in dental implant prosthodontics [1-5].

The most frequent cause of failure of dental implants is the loss of bone around the implant. Implants are in many respects similar to the roots of natural teeth. It is therefore unsurprising that when bone loss occurs around implants, it is largely due to the response of the peri-implant tissues to plaque [6] and may be exacerbated by metabolic disorders, smoking [7], the use of an inappropriate type of implant (too long or too wide), and poorly designed prostheses over the implant(s) which do not distribute occlusal loads evenly [8-10].

For many years, mobility of teeth, and more recently implants, has been assessed by clinical techniques based on tactile sensation [11], especial-

ly during the early, empiric period of oral implantology.

However, during the last two decades, tooth and implant mobility have also been detected using a device (*Periotest*; Siemens AG, Bensheim, Germany) (*Figure 1*). For the last ten years, the Department of Prosthodontics and Oral Implantology (Victor Babes University of Medicine and Pharmacy, Timisoara, Romania) has used a *Periotest* device. The measuring unit for *Periotest* is a value from a 58-unit scale (*Periotest* values; PTVs), with a range from -08 (low mobility) to +50 (high mobility) [12]. There is a correspondence between the scale values and real mobility: PTV -6 represents a movement of 0.038 mm, PTV +2 represents 0.113 mm, as determined by an axial movement testing device. None of these readings can be detected manually. When determining implant mobility, the typical PTVs obtained are defined as ranging from -5 to + 5. These values represent a narrower range on the instrument's scale than for tooth mobility measurements [13].

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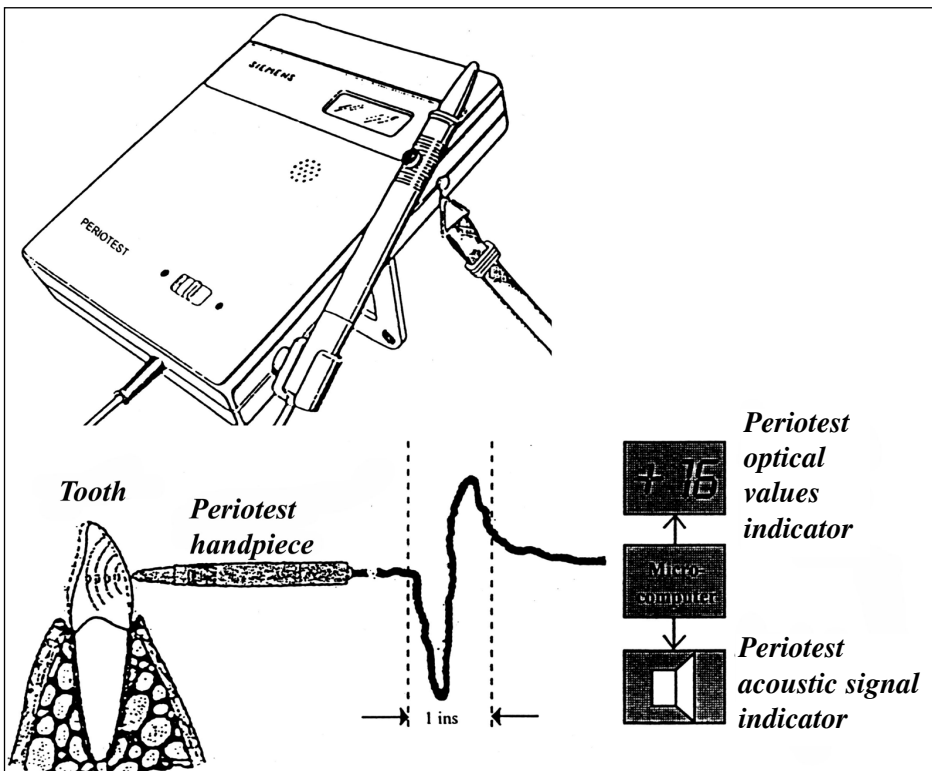


Figure 1. Periotest: the device and how it functions.

A number of studies have suggested that Periotest is not an ideal device for measuring the implant/bone interface. Periotest cannot accurately inform the clinician about minor changes in this bone/implant interface.

Thomson (1988) [14] stated that the resonance frequency of a vibrating structure is an important parameter related to the rigidity and density of that structure. Sennerby and Meredith (1998) [15] suggested that there was a direct proportionality between resonance frequency, the rigidity of the bone/implant interface and the distance from the implant platform to the ridge of the alveolar process. As a result of work in animal models, it was observed that resonance frequency rises during maturation of the bone/implant interface [16]. This finding led to the development of the Osstell Mentor device, the first to use resonance frequency analysis (RFA) for determining the stability of a dental implant [16,17]. Osstell is a portable device using a noninvasive technology based on RFA (Figure 2). The instrument's dimensions are 150x70x35 mm, it weighs 0.2 kg, and it operates from 10 to 40°C and in relative humidity of 30-75%. A measurement probe (Figure 2a) is attached to the instrument. A special piece (a smartpeg) is attached to the implant (or implant abutment) and it is activated by the electromagnetic pulse produced by the measurement probe.



Figure 2. Osstell Mentor and its components. a) Instrument and handpiece (measurement probe); b) Docking station.

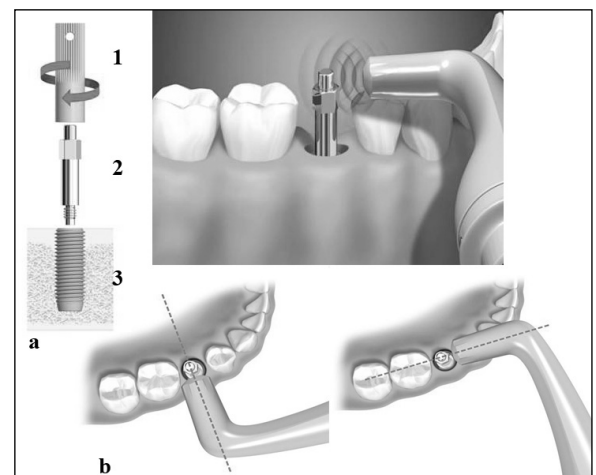


Figure 3. Determination of the implant stability quotient (ISQ). a) 1=Key (handling device for smartpegs); 2=Smartpeg; 3=Implant; b) Measuring from different directions.

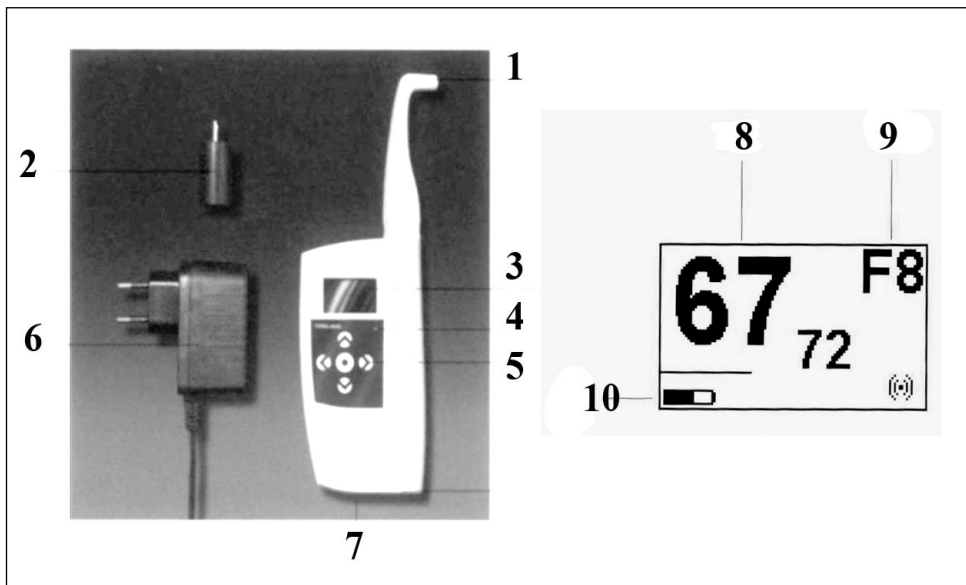


Figure 4. Osstell Mentor. 1=Measuring probe-handpiece; 2=Testpeg; 3=Display; 4=Activity LED; 5=Keypad; 6=AC/DC adapter; 7=Electric coupling for instrument or docking station; 8=ISQ; 9=Memory position for recording the measured reading; 10=Loading status of the battery.

After mounting/attaching the smartpeg to the implant or implant abutment (Figure 3), the measurement probe is moved towards the implant from two different angles (Figure 3b). Each time the measurement probe is close enough to the smartpeg, a beep is heard and a number from 1 to 100, representing the implant stability quotient (ISQ), appears on a screen. The ISQ corresponding to the resonance frequency is measured. The higher the number on the screen, the higher the implant stability.

The Osstell Mentor kit also has a testpeg (a black and white cylinder) with a factory-mounted smartpeg. The testing place for positioning the measuring probe is marked with a red dot on the testpeg.

The measuring probe emits magnetic pulses as high as 20 Gauss, at a minimum distance of 8 mm to the implant-mounted smartpeg. The instrument is calibrated by EN 60601-1, EN 60601-1-2 and UL 2601-1 standards, and also meets ISO (International Organization for Standardization) 9687 and IEC (International Electrotechnical Commission) 417 standards.

The instrument is linked to the probe by a cable connection. It has a liquid crystal display (LCD) and a keypad. On the display, three values are shown: ISQ (see 8 in Figure 4), memory position of the reading (see 9 in Figure 4), and loading status of the battery (see 10 in Figure 4).

The Osstell Mentor can be used stand-alone, with the measuring probe inserted directly into the instrument's interface (Figure 4), or with a cable link for free movement of the measuring probe at a distance. When not in use, the device can be posi-

tioned in its docking station, which has two couplings: one for DC current 5V-1.6A (from the AC/DC adapter) and the other for a computer connection (Figure 5).



Figure 5. Device positioned in the docking station.

Data transmission from the instrument to the docking station is made by infrared connection. The battery for the instrument is charging when it is positioned in the docking station.

Pressing any button on the keyboard turns the instrument on. To switch off the instrument, it is necessary to enter the main menu (by pressing the central button) and then use the up or down arrow until the 'shut down' option is highlighted. By pressing the central button, the operation is confirmed. After a measurement, the instrument turns off on its own following 5 to 30 seconds of inactivity. Readings can be achieved with the measurement probe connected directly to the instrument or through the link cable. Osstell Mentor can be used even while charging in its docking station. No cable

connected to the instrument is screwed or turned in its coupling; all cable connections use the push/pull system.

The instrument's memory is an array with rows 1-20 and columns A-T. A single reading can be recorded in every cell of the array. ISQ values determined with the instrument may be recorded on the patient's chart or stored on a PC, through USB transfer using the Osstell Data Manager program.

Ideally, an ISQ reading should be taken immediately after implant placement, repeated six months following placement or when loading the implant, and then taken for the third time after six months of functional use (after loading).

Aims

Against this background, the current study aimed at assessing the accuracy and reliability of an Osstell device in measuring the mobility of TimPlant (OR-VIT Bologna, Italy) dental implants that supported Kennedy class I and II fixed partial dentures.

Methods

This clinical study was performed in the Department of Oral Implantology, Faculty of Dental Medicine, Victor Babes University of Medicine and Pharmacy, Timisoara, Romania, between February 2007 and March 2009. The study included 34 patients (15 males and 19 females), aged between 43 and 80 years, who presented with class I and II Kennedy edentulous spaces, without the need for hard- and/or soft-tissue grafting. The patients had previously had 105 TimPlant (OR-

VIT, Bologna, Italy; imported by SINTEZE, Timisoara, Romania) dental implants placed in the bicuspid-molar mandibular region and loaded with fixed prosthesis, in order to restore the edentulous spaces. The implants were all stage II TimPlant. The lengths of the implants that were assessed are detailed in *Table 1*.

Table 1. Number of Implants Used and Their Length

Length of implants (mm)	Number of implants
8.5	7
10	53
12	22
13	15
15	8

No bone-grafting techniques had been used. All the patients had taken prophylactic antibiotics (Augmentin 2 g/day; GlaxoSmithKline, Brentford, United Kingdom) for five days after implant insertion. After a healing period of three to six months, the implants had been loaded. All the fixed prostheses were solely implant-supported by two or three implants and were cemented with long-term provisional cement. They were assessed using the Osstell device as follows.

A smartpeg was attached to the implant or abutment. The measurement probe was closed towards the smartpeg, without touching it. A beep

Table 2. Osstell Readings for the Implants 1-2 Years After Their Placement

Implant characteristics		Implants n (%)	ISQ value
Number of implants/fixed prosthodontics	2	30 (28.8)	67.9 ± 5.25
	3	74 (71.2)	70.9 ± 6.41
Region where the implants are positioned	Bicuspid	64 (61.5)	70.1 ± 6.03
	Molar	40 (38.5)	70 ± 6.22
Implant length (mm)	8.5	7 (6.7)	70.9 ± 7.4
	10	52 (50)	70.8 ± 5.55
	12	21 (20.2)	69.2 ± 5.7
	13	14 (13.5)	67.2 ± 5.7
	15	10 (9.6)	71.8 ± 5.57
Bone resorption at implant cervix (mm)	0	57 (54.8)	70.2 ± 5.98
	1	36 (34.6)	69.6 ± 6.66
	2-3	11 (10.6)	71.4 ± 6.45
Fixed prosthodontics	Unilateral	77 (74.1)	70.3 ± 6.4
	Bilateral	27 (25.9)	69.4 ± 5.76

was heard from the instrument when the reading was complete and the ISQ value was shown on the display. Measurements were taken at different angles around the smartpeg, to detect both the highest and lowest stability for an asymmetrically inserted implant.

The apparent ISQ value was lower than expected when measuring an implant abutment or stage I implants (relative to measurements performed directly on stage II implants) because of the height difference between the crestal bone and the occlusal end of the implant.

Osstell readings were taken, with type 4 smartpeg, one to two years after the placement of the implants. Whenever the RFA measurements were performed, the prosthetic constructions needed to be removed.

As all the patients consented to take part in the study, after they had been informed that the use of the Osstell device was a routine part of their treatment and that they would not be identifiable in the report. It was considered unnecessary to seek ethical approval for the study.

Results

One hundred and five dental implants that had been placed in the mouths of 34 patients (15 male and 19 female) aged between 43 and 80 years were assessed. On clinical examination, 104 of these implants were found to be osseointegrated after functioning for about two years. They presented a medium ISQ value of 70.05 ± 6.07 (ISQ values between 59 to 90). The ISQ readings were classified by number of implants per restoration, region, bone resorption, and unilateral or bilateral fixed prostheses (*Table 2*).

It is noticeable that the readings for implants involved in triple-implant-supported fixed prostheses had a higher ISQ than those for double-implant-supported fixed prostheses. There were no significant differences between implants placed in the bicuspid area compared with those placed in the molar area. ISQ seemed not to be influenced by the presence of unilateral or bilateral fixed prostheses in the same patient, length of the implants and bone resorption up to 3 mm.

Discussion

As described in the introduction of this paper, in the past, mobility of implants has been assessed both visually and by using the Periotest device. It would therefore have been possible to use these tech-

niques in parallel with the Osstell device and to compare the results. However, because previous studies have reported the efficacy and improved accuracy of resonance frequency devices such as Osstell, it was thought unnecessary to do so.

The RFA testing method using the Osstell device has been claimed to be useful in monitoring implant osseointegration during the healing stage and in helping the dental clinician to decide when to load an implant [18].

Implant mobility has been tested with RFA for 12 years [16] and there have been several reports of its use [3,15,16,19,20]. In 2000, the results of a study on the biological, biomechanical and clinical aspects of measuring implant stability by resonance frequency analysis were reported [20].

In 2003, a further study highlighted the success rate in immediate-loaded implant-supported mandibular overdentures and measured implant stability using resonance frequency analysis [21].

In 2004, there was a report of a study in which the technique had been used to measure implant stability for immediate and delayed implants during the osseointegration period [22]. The following year, there was a further report of a study on the stability of immediate implants determined with resonance frequency analysis [23].

The results of the current study, the first of its kind to be performed in a Black Sea country, were comparable to those from the previous studies. The RFA technique using the Osstell device proved its value in providing clinically relevant information about the implant-bone interface in all treatment stages.

The main aim of the current study was to determine the stability of TimPlant dental implants over a one- to two-year follow-up examination. It was noticeable that after the healing and osseointegration period, implant stability was not decisively influenced by cervical bone resorption or by implant length. High ISQ values recorded in this study were indicative of the success of the implant-supported fixed prosthesis treatment, and may indicate a small risk for future failure.

Nevertheless, obtaining primary stability is important during implant placement thus the use of implants with a large diameter is indicated. To achieve primary implant stability, it is necessary to consider the length, diameter and positioning of the implant, although after osseointegration these factors seem to have less influence on implant stability. In the longer term, excellent oral hygiene around the implant is also crucial.

Conclusion

In this study, over a one- to two-year period after their placement, TimPlant dental implants achieved a stability similar to that reported for other implant systems [3, 5, 15, 16, 19-23].

Measuring implant stability with Osstell can provide useful information about the bone/implant interface in every treatment phase, because it is a

qualitative implant stability evaluation regarding the bone/implant interface. This qualitative determination is influenced by bone density, bone healing (remodelling) and the ratio of intraosseous and buccal length of the implant.

However, more clinical studies are needed to establish threshold ranges for detecting stable implants and implants at risk of losing stability, for different implant systems.

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