Wired/Classic and Wireless/Periotest "M" Instruments: An In Vitro Assessment of Repeatability of Stability Measurements

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This in vitro study evaluated agreement among 10 trained evaluators when assessing implant stability with the Wired/Classic and Wireless/Periotest "M." A difference of 1 Periotest value (PTV) between the wired (−7) and wireless (−8) instruments was observed for the pretest calibration ring. No significant differences were found between the instruments and for all evaluators for all tests (analysis of variance, $P < .05$). Each instrument can provide meaningful and reproducible recordings of stability measurements.

Key Words: Periotest, stability measurements, in vitro testing, dental implant

INTRODUCTION

Osseointegration of dental implants was introduced in 1985 by Branemark and his coworkers.[1] As clinical success rates increased, dentists expanded their use of implants to include more challenging prosthodontic applications.

Primary implant stability depends on bone-implant contact, bone density, and implant length, material, and design. During healing, secondary stability occurs with the formation of woven and lamellar bone.[2] Long-term clinical implant survival depends on the establishment and maintenance of integration sufficient to withstand the stresses encountered during function. Microstrains greater than 4000 produce microdamage that exceeds the threshold of bone tolerance[3] and could result in a gradual loss of integration.[4–6] At microstrains of about 3000, hypertrophic bone develops around the implant, which increases stability. Microstrains lower than 2000 could result in the loss of calcium and bone atrophy, which would likely result in decreased stability. Both short-term and long-term clinical success of implant-retained dental prostheses depend on the establishment and maintenance of a healthy bone-implant interface.

Regardless of the type of implant, the skill employed during implant placement, and prosthesis design, the bone-implant interface may begin to fail for a variety of reasons. Breakdown may occur gradually during the different stages of implant treatment without any obvious clinical signs. Unless the adverse conditions are corrected, catastrophic failure at the interface may result in a decrease of implant stability. Implants exhibiting significant clinical mobility are considered failures.

Over the years, dentists have used a variety of methods to determine when the bone-implant interface was sufficiently established for the dental prosthesis to be safely subjected to loading during function.[7] There is also a need to detect early signs of failure in order to introduce corrective interventional therapy to prevent the loss of the implant.

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Diagnostic methods have been limited in their ability to quantify the status of the interface or to measure changes that may have occurred over the course of treatment. Therefore, there is a need to quantify the status of the bone-implant interface during all stages of implant treatment.

There are currently available to the profession 2 instruments, the Osstell (Intergration Diagnostics, AB, Goteberg, Sweden) and the Periotest (Medizintechnik Gluden, Modautal, Germany), to quantify the health status of the bone-implant interface. Each device has studies that support its use.[8–12,14,15] The Osstell measurement is based on a continuous vibration of the implant. The instrument has been used in various studies to document changes in implant stability during healing, failure of the implant to integrate, supracrestal dimensions of the implant, and the degree of bone-implant contact.[13–15]

The Periotest uses a slightly different approach. It produces a transient vibration by tapping the implant 16 times over a period of 4 seconds as a rod inside of the Periotest hand piece is electromagnetically accelerated.[6–19,21] Implants that are stable cause the plunger to rebound rapidly. The time that the plunger is in contact with the implant is transmitted to a mini CPU located within the body of the Periotest, which converts the reading into a Periotest value (PTV) that ranges between −8 (clinically rigid) and +50 PTVs (very mobile).[20] The more negative the PTV, the more stable the implant. Chavez[22] reported in 1993 that clinically successful, stable, and functional implants resulted in PTVs that ranged from −6 to −2 PTVs.

Olive and Aparicio[16] suggested the Periotest was an easy-to-use objective instrument to assess implant stability. It has been observed that at the time of placement, PTVs of stable implants tend to be negative, somewhere in the range of −3 to −5 PTVs.[23] During the first 1 to 3 months after implant placement, the PTVs become more positive as healing and remodeling of bone occurs at the bone-implant interface. Following loading of the prosthesis, PTVs gradually become more negative as long as the stresses are within physiologically acceptable limits and below the microdamage threshold as hypertrophic bone forms at the bone-implant complex.

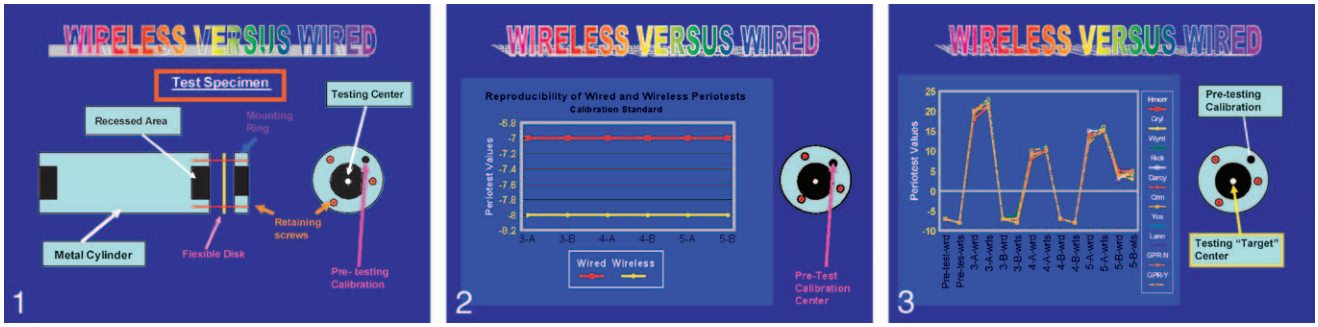
The "Classic/Wired" Periotest (Medizintechnik Gluden) instrument has been the subject of several studies with generally favorable results.[21–27] To compete with the Osstell, a wireless resonance frequency device, a wireless version of the Periotest (Periotest "M") has been introduced to the profession. To be accepted by clinicians involved in implant dentistry, an instrument designed to assess the health status of the bone-implant interface must be easy to use and provide reasonable and reproducible measurements of the status of this interface. The resulting measurements should reasonably reflect the heath status of the bone-implant complex and not be influenced widely by slight variations in clinical use or the dentist using it.

Any instrument intended to quantify implant stability over long periods of function by different evaluators, with varying clinical training, skills, and experience, must provide reproducible data. Therefore, the objectives of this in vitro study were (1) to determine if the wired and wireless Periotests provide reproducible data with a standardized calibration specimen and (2) to determine if an acceptable level of agreement exists between the 2 types of Periotest instruments when used by different evaluators to measure the mobility of specially designed and standardized test specimens.

Materials and Methods

Three metal test specimens were fabricated for use by the 10 evaluators (Figure 1). Solid aluminum cylinders were hollowed out at each end to provide a depression 1 cm in diameter and 2 mm in depth. The depressions were covered by thin metal membranes of different thicknesses fabricated from different alloy materials. The membranes were retained in place with retention rings that also served as pretest calibration rings (Figure 2). Before each test sequence, the evaluator would activate the instrument and record the PTV for the pretest calibration ring. If the pretest was completed correctly, the PTVs for the wired Periotest would be −7 PTVs and −8 PTVs for the wireless Periotest included in this study. These PTVs were determined at the time of fabrication of the test specimens. The evaluators were instructed to hold the hand piece at a 90° angle to the specimen to be tested and parallel to the floor for each test sequence.

When activated, each Periotest produces a characteristic sound, signaling that the test is being completed correctly. Evaluators were required to



Figures 1–3. Figure 1. Both ends of 3 aluminum cylinders were hollowed out to provide a depression 10 mm in diameter and 2 mm deep. The recessed area was covered with a thin metal membrane, which consisted of different metals with different thicknesses. Information about the membranes was not available to the participants. The retention ring also served as a calibration area before each test. **Figure 2.** Periotest values (PTVs) for the pretest calibration ring for each test specimen. The results show that the PTVs for each Periotest was reproducible prior to starting the testing of each specimen. **Figure 3.** The results of the testing of each test specimen shows agreement among the evaluators for both Periotests for all test specimens.

demonstrate that they could obtain 2 identical PTVs out of 3 test attempts, and this PTV was recorded. The wired instrument produced a moderate "bong" each time the plunger within the hand piece contacted the test specimen. The PTV was displayed on a digital scale on the hand piece while a digitally generated artificial voice announced the value. The same sequence using the wireless Periotest resulted in a softer, higher-pitch sound and a digital readout but without the audible artificial voice.

Before each test sequence, the evaluator activated the Periotest to test the calibration ring (Figures 1 and 2), which produced a −7 PTV (variance = 0) for the wired and −8 PTV (variance = 0) for the wireless Periotest. These PTVs ensured that the instruments were functioning correctly. For the study, the hand piece was directed to the center of the metal membrane and the instrument activated 3 times for each test specimen. If 2 of the 3 tests produced the same result, that PTV was recorded for that sequence. This sequence was repeated 3 times for each of the test specimens, and the data were recorded and entered into Excel 2007 for future analysis.

To reduce evaluator bias, the evaluators selected to participate in the study did not have any previous experience with the Periotest instrument. They were 4 dental hygienists, 2 general practice residents, and 4 staff dentists. All tests were completed without discussing the results among the evaluators to eliminate any potential of bias. All data were analyzed by an independent investigator using the analysis of variance (ANOVA) program within Excel 2007.

Results

Test data are displayed in Figure 3. The data were tested for significant differences between the 2 instruments and among all evaluators using the ANOVA. No significant difference was found between the data for the 2 Periotest instruments or the 10 different evaluators ($P < .05$).

Discussion

Although assessment of implant stability at the time of uncovering and abutment connection is important, equally critical is the determination of the status of the bone-implant interface after loading. Naert et al[28] reported no clinically significant difference between the PTVs at the time of uncovering/abutment connection and follow-up. In view of the importance of preventing implant failures, a longitudinal, reliable, quantitative test procedure could encourage dental researchers to focus on the development of intervention procedures to correct any conditions causing failure at the interface. This could eliminate the trauma and the costs associated with prosthesis removal, implant removal, and replacement. Since the Osstell instrument requires abutment and prosthesis removal to allow the placement of a "smart peg" to determine the implant stability quotient, the results of the study by Naert et al[28] suggest a possible

advantage of the Periotest in detecting changes in the bone-implant complex, if the longitudinal testing could be completed over time without removing the prosthesis. Their study suggested that implants splinted together should have similar PTVs when tested over a period of long-term clinical function; however, this possibility needs to be studied in more detail.

Conclusion

The results suggest that the wired and wireless Periotest instruments are capable of providing meaningful information concerning the status of the bone-implant interface and the resulting stability of the implant.

Abbreviation

PTV: Periotest value

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