The reliability of Anycheck device related to healing abutment diameter

Dong-Hoon Lee†, Yo-Han Shin†, Jin-Hong Park, Ji-Suk Shim, Sang-Wan Shin, Jeong-Yol Lee*
Department of Prosthodontics, Institute for Clinical Dental Research, Korea University Medicine, Korea University, Seoul, Republic of Korea

PURPOSE. The purpose of this in vitro study was to examine the reliability of the Anycheck device and the effect of the healing abutment diameter on the Anycheck values (implant stability test, IST). MATERIALS AND METHODS. Thirty implants were placed into three artificial bone blocks with 10 Ncm, 15 Ncm, and 35 Ncm insertion torque value (ITV), respectively (n = 10). (1) The implant stability was measured with three different kinds of devices (Periotest M, Oststell ISQ Mentor, and Anycheck). (2) Five different diameters (4.0, 4.5, 4.8, 5.5, and 6.0 mm) of healing abutments of the same height were connected to the implants and the implant stability was measured four times in different directions with Anycheck. The measured mean values were statistically analyzed. RESULTS. The correlation coefficient between the mean implant stability quotient (ISQ) and IST value was 0.981 (P<.01) and the correlation coefficient between the mean periostest value (PTV) and IST value was -0.931 (P<.01). There were no statistically significant differences among the IST values with different healing abutment diameters. CONCLUSION. There was a strong correlation between the Periotest M and Anycheck values and between the ISQ and IST. The diameter of the healing abutment had no effect on the Anycheck values. [J Adv Prosthodont 2020;12:83-8]

KEYWORDS: Implant stability; Periotest; Implant stability test; Insertion torque value; Implant stability quotient (ISQ)

INTRODUCTION

The stability of a dental implant is used to predict the prognosis of the implant. The stability of an implant was defined as the ability of an implant to resist vertical, horizontal, and rotational forces and was employed as an indirect index of osseointegration and successful healing.1 Osseointegration occurs in two stages, the primary and secondary stages.2 In the primary stage, implant stability is mainly achieved from mechanical engagement with cortical bone. In contrast, in the secondary stage, implant stability is achieved through bone regeneration and remodeling.3

Adequate primary stability is a prerequisite for acceptable osseointegration. It is, therefore, imperative to quantify implant stability at several time points and predict long-term prognosis based upon the obtained implant stability measurements.

There are several methods to measure primary stability and some techniques involve non-invasive quantitative analysis, such as resonance frequency analysis (RFA) and damping capacity analysis (DCA).4,5 One of the RFA devices, the Osstell ISQ Mentor (Osstell, Göteborg, Sweden), uses a sensor (smart-peg) coupled with an implant fixture and measures resonance frequency values that are converted into an arbitrary implant stability scale values called the implant stability quotient (ISQ).6 DCA systems are designed to measure the damping characteristics of implants based on the contact time.

One DCA system device, Periotest M (Medizintechnik Gulden, Modautal, Germany), converts the measured contact time into arbitrary implant scale values called Periotest values (PTV).7 Some studies have investigated the ability of these non-invasive devices to measure implant stability and confirmed their reliability.8,9,10 However, the correlation and reliability of both methods are controversial.11 Some studies have shown a strong correlation between ISQs and PTVs, where-

†These authors contributed equally to this work.
as others have shown no correlation. Because of these discrepancies, standard implant stability values have not yet been established and evaluations have been made with other methods of analysis, such as radiographic and clinical examinations, and measurement of insertion torque.

A new damping capacity method device, Anycheck (Neobiotech, Seoul, Korea) was introduced in 2017. This device measures the time of contact between the impacting-rod and the healing abutment. It strikes the healing abutment six times over during three seconds and converts the time into the implant stability test (IST) values. This device strikes the healing abutment with less force compared to the Periotest M and has a function to stop automatically when the stability is low, to protect the implant. However, little is known about the reliability of this device or the factors affecting the IST values. The purpose of this in vitro study was to examine the reliability of the Anycheck device and the effect of the healing abutment diameter on IST values.

MATERIALS AND METHODS

An artificial bone block (Sawbones, Pacific Research Laboratories, Vashon, WA, USA) with 0.32 g/cm³ density was used in this experiment. Three artificial bone blocks of the same size (Horizontal × Vertical × Height: 80 mm × 10 mm × 20 mm) were prepared (Fig. 1).

Thirty CMI IS-II implants (Neobiotech, Seoul, Korea) with 4.0 mm diameter and 10.0 mm length were used in this experiment. CMI IS-II implants were installed into three artificial bone blocks with 10 Ncm, 15 Ncm, and 35 Ncm insertion torque values (ITV), respectively (n = 10). Different drilling processes were applied to each block. For 10 Ncm ITV, the drilling process included point lindemann drill, surgical drill (∅2.2, 3.0, 3.5, 4.0 mm) and cortical tap drill to get even ITV value. For 15 Ncm, the drilling process included point lindemann drill, surgical drill (∅2.2, 3.0, 3.5, 4.0 mm).

For 30 Ncm ITV, the drilling process included point lindemann drill, surgical drill (∅2.2, 3.0, 3.5 mm). The distance between the implants was 3.5 mm and the space between the edge of the block and the implant was 4.2 mm on each side.

For examining the reliability of Anycheck device, experimental groups were established according to the ITVs and the devices used to measure implant stability (Table 1). The sensor, smart-peg, was coupled to the CMI IS-II implant fixtures (n = 30, ITV: 10 Ncm, 15 Ncm, 35 Ncm). ISQ values were measured in each implant in four different directions (buccal, lingual, mesial, and distal) and the mean ISQ values were recorded by one examiner.

Healing abutments (Neobiotech, Seoul, Korea, Diameter × Cuff: 4.0 mm × 4.0 mm) were connected to the CMI IS-II implants (n = 30, ITV: 10 Ncm, 15 Ncm, 35 Ncm).

Lines were drawn 1 mm under the top of the healing abutment (Fig. 2) to standardize the height of the healing abutments for measurement by Periotest M and Anycheck.

Three bone blocks were fixed parallel to the ground and the rods hit perpendicular to the long axis of the healing abutment. Periotest M and Anycheck were used to measure implant stability when the devices were parallel to the

Table 1. Experimental groups used for correlation tests of the reliability of Anycheck values

| Measuring device | Insertion torque (Ncm) |
|------------------|-----------------------|
| IST (Anycheck value) | (n = 10) (n = 10) (n = 10) |
| ISQ (Osstell Mentor value) | (n = 10) (n = 10) (n = 10) |
| PTV (Periotest M value) | (n = 10) (n = 10) (n = 10) |

Fig. 1. A mimetic diagram of the block bone model. The size of the artificial block bone was: horizontal length, 80 mm; vertical length, 10 mm; and height; 20 mm. Ten CMI IS-II implants were installed with distances of 3.5 mm between the implants and spaces of 4.2 mm from the edge of the block.

Fig. 2. Healing abutment with the line marked on it. A line was marked on each healing abutment 1 mm from the top of the healing abutment to standardize the heights for measurement by Periotest M and Anycheck.
ground. The PTVs and IST values were measured in four different directions (buccal, lingual, mesial, and distal) (Fig. 3) and the mean values were recorded by one examiner.

For examining the effect of healing abutment diameter on IST value, experimental groups were established according to the healing abutment diameter and ITVs to determine the effect of the healing abutment diameter (Table 2).

Healing abutments (diameters: 4.0 mm, 4.5 mm, 4.8 mm, 5.5 mm, and 6.0 mm, cuff: 4.0 mm) were connected to the CMI-II implants (n = 30, ITV values: 10 Ncm, 15 Ncm, and 35 Ncm) with 10 Ncm torque using a torque ratchet. The IST values were measured in four different directions (buccal, lingual, mesial, and distal) (Fig. 3) and the mean values were recorded by one examiner.

Statistical analyses were conducted with SPSS statistics 20.0 (IBM, Chicago, IL, USA). Pearson’s correlation test was conducted to analyze the correlation between ISQ and IST and between PTV and IST. One-sample Kolmogorov-Smirnov tests were conducted to test the normality of the obtained data and, based on the result of this test, two-way ANOVA tests were conducted to analyze the effect of the healing abutment diameter on the IST value. Tukey’s post-hoc tests were conducted.

### RESULTS

The correlation coefficient between the mean ISQ value and the mean IST value was 0.981, demonstrating a strong positive correlation (P < .01) (Fig. 4). In addition, the correlation coefficient between the mean PTV value and the mean IST value was -0.931, demonstrating a strong negative correlation (P < .01) (Fig. 5).

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**Table 2.** Experimental groups for correlation tests of Anycheck

| Diameter (Healing abutment, mm) | Insertion torque (Ncm) |
|---------------------------------|------------------------|
| 4.0                             | (n = 10)               |
| 4.5                             | (n = 10)               |
| 4.8                             | (n = 10)               |
| 5.5                             | (n = 10)               |
| 6.0                             | (n = 10)               |

**Fig. 3.** Measuring the Anycheck value. Healing was connected to the implant with 10-Ncm torque and the implant stability was measured with the Anycheck device in four different directions (buccal, lingual, mesial, and distal).

**Fig. 4.** The result of Pearson’s correlation between the mean ISQ values (ISQAVG) and mean IST values (ISTAVG). The correlation coefficient was 0.981 (P < .001).

**Fig. 5.** The result of Pearson’s correlation between mean PTV values (PTVAVG) and mean IST values (ISTAVG). The correlation coefficient was -0.931 (P < .001).
The IST values were proportional to the ITV of the implants, indicating that the IST value could be an indirect index of primary implant stability based on the insertion torque (Fig. 6). When the ITV was 10 Ncm, the mean IST value according to healing abutment diameters are as follows: 62.67 ± 1.19 (4.0 mm), 62.32 ± 1.93 (4.5 mm), 62.15 ± 1.09 (4.8 mm), 61.52 ± 1.5 (5.5 mm), 61.35 ± 1.77 (6.0 mm). When ITV was 15 Ncm, the mean IST values are as follows: 65.97 ± 1.16 (4.0 mm), 65.12 ± 0.81 (4.5 mm), 64.72 ± 0.83 (4.8 mm), 65.32 ± 1.26 (5.5 mm), 64.6 ± 0.67 (6.0 mm). When ITV was 35 Ncm, the mean IST values are as follows: 74.82 ± 1.69 (4.0 mm), 73.52 ± 2.48 (4.5 mm), 73.75 ± 1.65 (4.8 mm), 74.6 ± 1.46 (5.5 mm), 74.4 ± 1.55 (6.0 mm) (Fig. 7). However, there were no statistically significant differences among the IST values with different healing abutment diameters (P = .505).

Fig. 6. The implant stability test (IST) values of implants with different insertion torque values (ITV). The IST values were significantly different among the implants installed with different ITVs with different healing abutment diameters.

Fig. 7. Implant stability test (IST) value of implants with different healing abutment diameter. The IST value had no statistically different among healing abutment diameters with the same ITV value.
DISCUSSION

Studies have reported that both the Periotest and Osstell ISQ devices could reliably measure implant stability. Lachmann et al. insisted that both the Periotest and Osstell ISQ showed acceptable reliability in predicting the stability of implants in an in vitro experiment.15 Pang et al.11 also showed a strong association between the ISQs and PTVs after surgery and two months later. An animal study demonstrated a strong correlation between ISQs and PTVs.12 In addition, some studies reported that although both the Periotest and Osstell ISQ systems were useful for evaluating implant stability, the Osstell ISQ system performed more accurately than the Periotest device, showing high reliability.16,17 However, some studies have reported conflicting results for both the Periotest and the Osstell ISQ devices.12,18 Considering this controversy, both the Periotest and the Osstell ISQ devices were tested with Anycheck device. In addition, there was no information about healing abutment diameter. In vitro test for the reliability and effect of healing abutment diameter would be appropriate for setting conditions for further in vitro experiment. The results showed that the IST values were strongly correlated with both the PTVs and ISQs, suggesting that the IST values follow the tendency of PTV and ISQ values.

There are well known limitations and inconveniences of the Periotest and Osstell devices. Long-term data of Periotest have shown that it can be an objective measurement of implant stability.19,20 However, some studies have pointed out that these devices lack sensitivity.21,22 This is because Periotest, designed for natural dentition, measures a wide dynamic range (-8 to 50). However, the dynamic range used for measuring implant stability is limited to between -5 and +5.13 Other studies have suggested that an even narrower dynamic range of -4 to -2 or -4 to +2 is needed for clinically osseointegrated implants.23,24 Moreover, PTV cannot identify implants with borderline stability or those in the process of osseointegration.25 PTVs have also been criticized for lack of resolution and vulnerability to operator variables.22,26 The Osstell ISQ is a noninvasive method that can measure implant stability and based on the principle of structural analysis.27 This device can be fairly reliable when an implant has achieved osseointegration and the bone-implant interface is rigid. However, when the bone-implant interface is not rigid or doubtful, the ISQ tends to fluctuate.28,29 In addition, use of the Osstell ISQ requires removal of the upper component of the fixture (cover screw or healing abutment) and connection of the smart-peg when measuring implant stability and this may cause inconvenience and limitations.

The newly developed Anycheck device values were consistent with ISQ values. In addition, the Anycheck device values ranges from 1 to 99. The tapping motion was also improved with lesser tapping times and forces applied to the implant, resulting in safer measuring of implant stability than that of the Periotest. Use of the Anycheck does not require unscrewing the healing abutment and thus the process is easier than that of Osstell ISQ.

One study used the Periotest device to measure implant stabilities, regardless of whether the patients had single crowns, abutments, or healing abutments. The results showed that the diameter of the implant supra structure did not affect the IST value. If this idea can be applied to the Anycheck device, there is a possibility of measuring implant stability not only before the delivery of the prosthesis but also after the delivery of prosthesis. However, further studies investigating the effect of the curvature of the prosthesis and prosthetic material on IST values of the final prostheses are required before the Anycheck device is used clinically.

The limitation of this in vitro study was that the reliability of Anycheck was based on the correlation between the other devices and the agreement rate of each device was not measured in this experiment. In addition, the study design cannot compare the devices in osseointegrated implants and further in vivo studies are required for the clinical usage. The correlation between the devices may reveal tendencies toward implant stability but cannot suggest exact values indicating implant prognosis. Further studies are required to determine the reliability of the Anycheck device for clinical use.

CONCLUSION

Within the limitations of this study, we can conclude that the IST values had as strong positive correlation with the ISQ values and a strong negative correlation with the PTVs. In addition, based on the results of this study, the diameter of the healing abutment had no statistically significant effect on the IST values. The Anycheck device demonstrated relative reliability based on the reliability of Osstell and Periotest M. The device can be applied to the various diameters of healing abutments because the IST values were not affected by the diameter of the healing abutments.

ORCID

Dong-Hoon Lee  https://orcid.org/0000-0002-9592-3259
Yo-Han Shin  https://orcid.org/0000-0003-0341-1078
Jin-Hong Park  https://orcid.org/0000-0002-3220-9912
Ji-Suk Shim  https://orcid.org/0000-0002-4112-6051
Sang-Wan Shin  https://orcid.org/0000-0002-3100-2020
Jeong-Yol Lee  https://orcid.org/0000-0003-3079-0376

REFERENCES

1. Atsumi M, Park SH, Wang HL. Methods used to assess implant stability: current status. Int J Oral Maxillofac Implants 2007;22:743-54.
2. Meredith N. Assessment of implant stability as a prognostic determinant. Int J Prosthodont 1998;11:491-501.
3. Sennery I, Roos J. Surgical determinants of clinical success of osseointegrated oral implants: a review of the literature. Int J Prosthodont 1998;11:408-20.
4. Sennery I, Meredith N. Implant stability measurements us-
Winkler S, Morris HF, Spray JR. Stability of implants and natural teeth as determined by the Periotest over 60 months of function. J Oral Implantol 2001;27:198-203.

Truhlar RS, Morris HF, Ochi S. Stability of the bone-implant complex. Results of longitudinal testing to 60 months with the Periotest device on endosseous dental implants. Ann Periodontol 2000;5:42-55.

Pang KM, Lee JW, Lee JY, Lee JB, Kim SM, Kim MJ, Lee JH. Clinical outcomes of magnesium-incorporated oxidised implants: a randomised double-blind clinical trial. Clin Oral Implants Res 2014;25:616-21.

Oh JS, Kim SG, Lim SC, Ong JL. A comparative study of two noninvasive techniques to evaluate implant stability: Periotest and Osstell Mentor. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2009;107:513-8.

Cehreli MC, Karasoy D, Akca K, Eckert SE. Meta-analysis of methods used to assess implant stability. Int J Oral Maxillofac Implants 2009;24:1015-32.

Devlin H, Horner K, Ledgerton D. A comparison of maxillary and mandibular bone mineral densities. J Prosthet Dent 1998;79:323-7.

Lachmann S, Laval JY, Jäger B, Axdén D, Gomez-Roman G, Grotten M, Weber H. Resonance frequency analysis and damping capacity assessment. Part 2: peri-implant bone loss follow-up. An in vitro study with the Periotest and Osstell instruments. Clin Oral Implants Res 2006;17:80-4.

Herrero-Climent M, Santos-Garcia R, Jaramillo-Santos R, Romero-Ruiz MM, Fernández-Palacin A, Lázaro-Calvo P, Bullón P, Rios-Santos J. Assessment of Osstell ISQ’s reliability for implant stability measurement: a cross-sectional clinical study. Med Oral Patol Oral Cir Bucal 2013;18:e877-82.

Zix J, Hug S, Kessler-Liechti G, Mierckx-Stern R. Measurement of dental implant stability by resonance frequency analysis and damping capacity assessment: comparison of both techniques in a clinical trial. Int J Oral Maxillofac Implants 2008;23:525-30.

Andreatti AM, Goiato MC, Nobrega AS, Freitas da Silva EV, Filho HG, Pelligzer EP, MicheleneDos Santos D. Relationship between implant stability measurements obtained by two different devices: A systematic review. J Periodontol 2017;88:281-8.

Walker L, Morris HF, Ochi S. Periotest values of dental implants in the first 2 years after second-stage surgery: DICRG interim report no. 8. Dental Implant Clinical Research Group. Implant Dent 1997;6:207-12.

Truhlar RS, Morris HF, Ochi S. Stability of the bone-implant complex. Results of longitudinal testing to 60 months with the Periotest device on endosseous dental implants. Ann Periodontol 2000;5:42-55.

Meredith N, Friberg B, Sennerby L, Aparicio C. Relationship between contact time measurements and PTV values when using the Periotest to measure implant stability. Int J Prosthodont 1998;11:269-75.

van Steenbergh D, Tricio J, Naert I, Nys M. Damping characteristics of bone-to-implant interfaces. A clinical study with the Periotest device. Clin Oral Implants Res 1995;6:31-9.

Morris HE, Ochi S, Crum P, Orenstein I, Plezia R. Bone density: its influence on implant stability after uncovering. J Oral Implantol 2003;29:263-9.

Teerlink J, Quirynen M, Darius P, van Steenbergh D. Periotest: an objective clinical diagnosis of bone apposition toward implants. Int J Oral Maxillofac Implants 1991;6:55-61.

Hürzeler MB, Quiñones CR, Schüpbach P, Vlassis JM, Strub JR, Caffesse RG. Influence of the suprastructure on the peri-implant tissues in beagle dogs. Clin Oral Implants Res 1995;6:139-48.

Salvi GF, Lang NP. Diagnostic parameters for monitoring peri-implant conditions. Int J Oral Maxillofac Implants 2004;19:116-27.

Sekiguhi J. An attempt to measure viscoelasticity of human facial skin by impact hammer method. J Kanagawa Odontol Soc 1992;26:387-411.

Nedir R, Bischof M, Szmukler-Moncler S, Bernard JP, Samson J. Predicting osseointegration by means of implant primary stability. Clin Oral Implants Res 2004;15:520-8.

Friberg B, Sennerby L, Linden B, Gröndahl K, Lekholm U. Stability measurements of one-stage Brånemark implants during healing in mandibles. A clinical resonance frequency analysis study. Int J Oral Maxillofac Surg 1999;28:266-72.