The reliability of Anycheck device related to healing abutment diameter

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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, Osstell 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 meant periotest 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]

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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).[4-7] 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).[8] 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).[6]

Some studies have investigated the ability of these non-invasive devices to measure implant stability and confirmed their reliability.[2,9,10] However, the correlation and reliability of both methods are controversial.[11] Some studies have shown a strong correlation between ISQs and PTVs, where-

as others have shown no correlation.[12,13] 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/cm^3 density was used in this experiment.[14] 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 (Ø2.2, 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 (Ø2.2, 3.0, 3.5, 4.0 mm). For 30 Ncm ITV, the drilling process included point lindemann drill, surgical drill (Ø2.2, 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)		
	10	15	35
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)

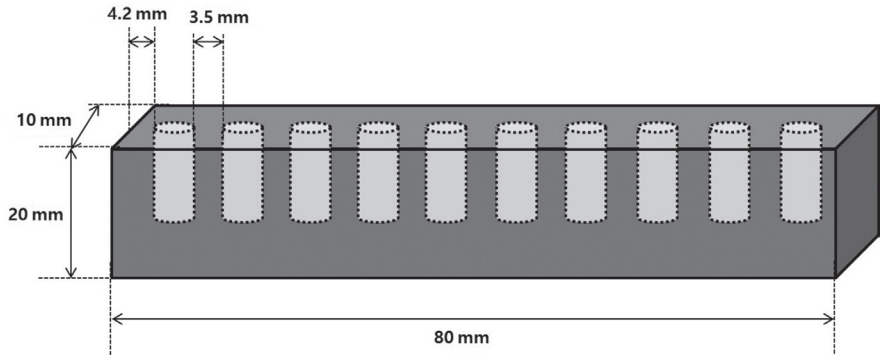

Fig. 1. A mimetic diagram of the block bone model. The size of the artificial block bone was: horizontal length, 80 mm; vertical length, 10 mm; and height; 20 mm. Ten CMI IS-II implants were installed with distances of 3.5 mm between the implants and spaces of 4.2 mm from the edge of the block.

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.

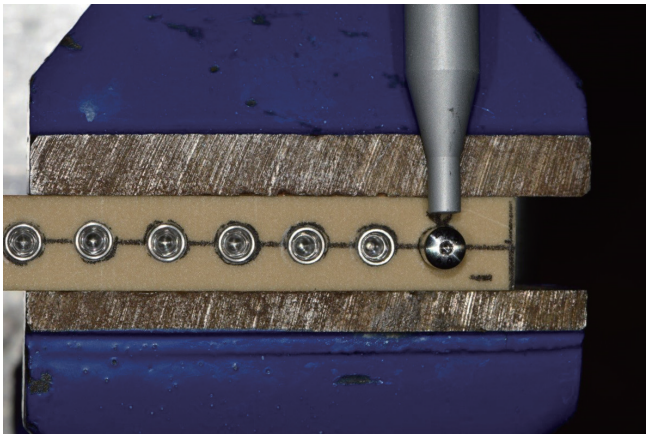

Fig. 3. Measuring the Anycheck value. Healing was connected to the implant with 10-Ncm torque and the implant stability was measured with the Anycheck device in four different directions (buccal, lingual, mesial, and distal).

Table 2. Experimental groups for correlation tests of Anycheck

Diameter (Healing abutment, mm)	Insertion torque (Ncm)		
	10	15	35
4.0	(n = 10)	(n = 10)	(n = 10)
4.5	(n = 10)	(n = 10)	(n = 10)
4.8	(n = 10)	(n = 10)	(n = 10)
5.5	(n = 10)	(n = 10)	(n = 10)
6.0	(n = 10)	(n = 10)	(n = 10)

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).

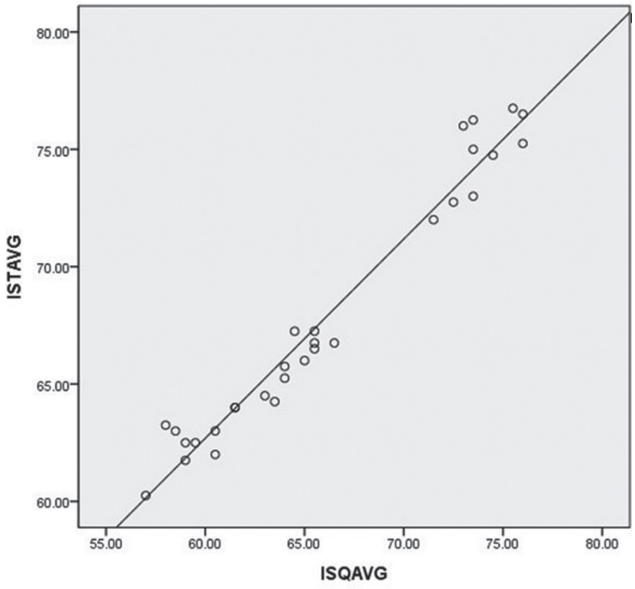

Fig. 4. The result of Pearson's correlation between the mean ISQ values (ISQAVG) and mean IST values (ISTAVG). The correlation coefficient was 0.981 ($P < .001$).

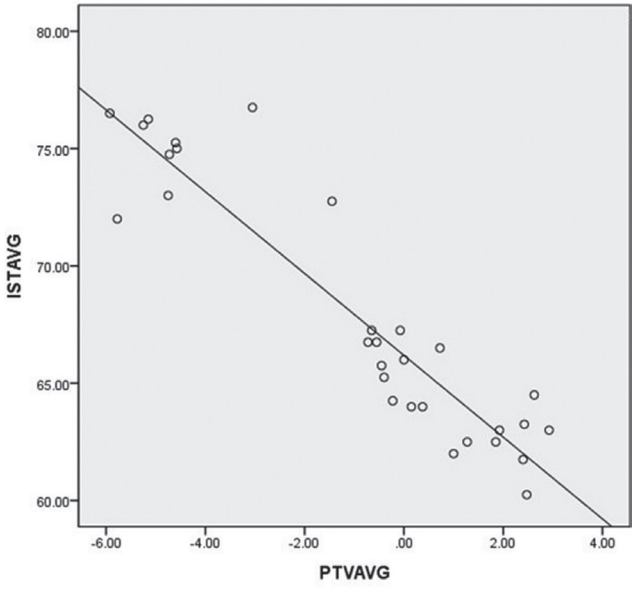

Fig. 5. The result of Pearson's correlation between mean PTV values (PTVAVG) and mean IST values (ISTAVG). The correlation coefficient was -0.931 ($P < .001$).

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).

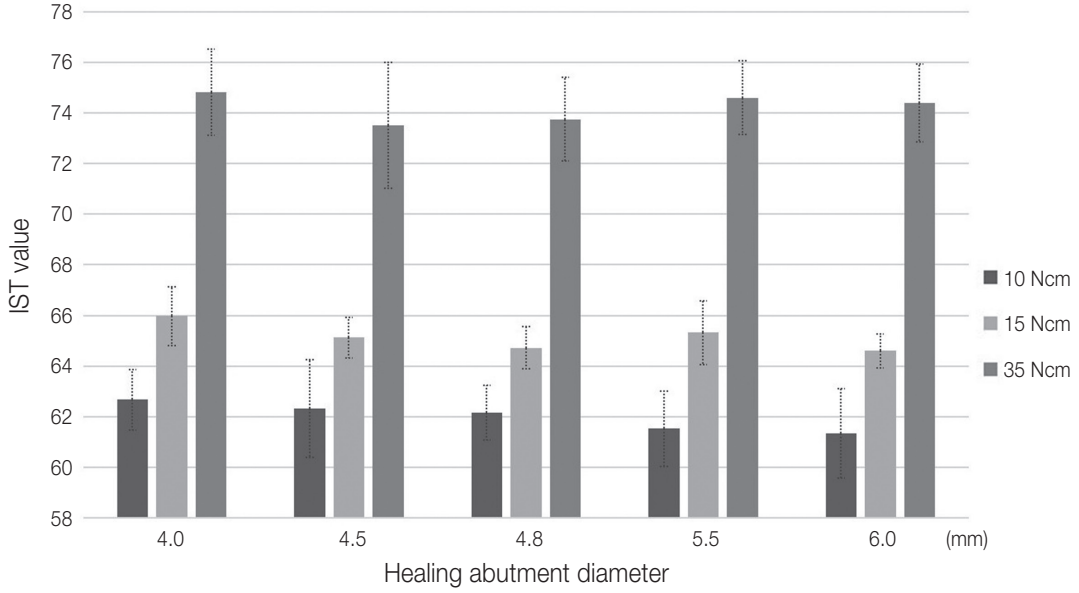

Fig. 6. The implant stability test (IST) values of implants with different insertion torque values (ITV). The IST values were significantly different among the implants installed with different ITVs with different healing abutment diameters.

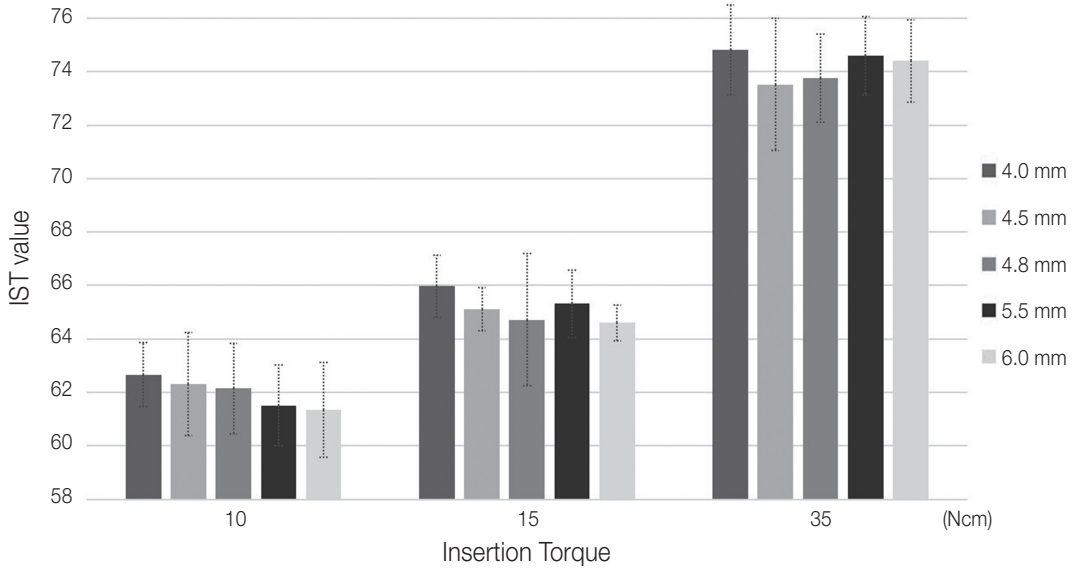

Fig. 7. Implant stability test (IST) value of implants with different healing abutment diameter. The IST value had no statistically different among healing abutment diameters with the same ITV value.

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 dimeter. *In vitro* test for the reliability and effect of healing abutment diameter would be appropriate for setting conditions for further *in vivo* 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.[2,26]

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.

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