Determination of Immediate-loaded Single Implants’ Stability with Periotest

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Abstract

Aim and objective: The aim of this study was to determine the stability of immediate-loaded single implants with periotest.

Materials and methods: In this in vivo study, dental implants with a length ranging from 10 to 13 mm and diameter of 3.0–4.2 mm were utilized. Stability of dental implant was evaluated using the Periotest® M handheld device before loading, at 1 month, 3 months, 6 months, and 1 year.

Results: Implants 11.5 mm in length had the highest mean periotest value (0) after placement, whereas 10 mm-long implant had a value of −0.31 and 13 mm had a value of −0.48. After 1 month, 10 mm had a value of 1.23, 11.5 mm had a value of −0.32, and 13.0 mm had a value of −0.24. After 6 months, 10 mm had a value of 1.78, 11.5 mm had a value of −0.4, and 13.0 mm had a value of −0.41. After 1 year, 10 mm had a value of −0.54, 11.5 mm had a value of −0.51, and 13.0 mm had a value of −0.48. There was an unconstructive relationship between implant length and the average periotest score. There was also an unconstructive association between the implant diameter and the mean periotest value.

Conclusion: The implant with long and greatest diameter had higher stability. Periotest can be used to determine dental implant stability.

Clinical significance: Periotest is useful in determining dental implant stability. Large-scale studies may be helpful in obtaining useful results.

Keywords: Dental implant, Periotest, Stability.

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Introduction

Since its innovation, dental implant has witnessed several developments to be more beneficial for patients with long time continued existence.¹ The purpose of dental implant is to achieve few operational criteria as follows: should diminish the outcome of shear forces on the implant bone boundary in order to preserve marginal bone,² should encourage bone development and/or aid in bone healing, and should achieve preliminary stability that lessens micromotion and the waiting period for loading the implant.³ There are different shapes of dental implants, such as smooth cylindrical, tapered, and threaded cylindrical.⁴ The most common site of insertion for tapered implants is the anterior region, whereas in posterior region, both smooth cylindrical and threaded cylindrical implants can be utilized safely.⁵ Threaded dental implants are added in order to improve initial stability. They are also utilized for distributing stress effectively. More stress exists at the thread–bone interface, and it decreases from the crest to root the of the thread.⁶

Nowadays, direct loading type or early functional loading type dental implant systems are utilized. Primary implant stability is greatly affected by length, width, design, bone quality, insertion torque, and micromotions at the bone implant interface.⁷ The periotest provides a more consistent method for diagnosing the implant status by calculating the levels of subclinical mobility. It is an electronic instrument that utilizes ultrasonic vibrating probe in order to determine the micromobility of the implant.⁸ This study was conducted to determine the stability of immediate-loaded single implants with periotest.

Materials and Methods

The present in vivo study was carried out in the Department of Periodontics and Oral Implantology. The study included 60 patients aged 18–58 years in both genders. The inclusion criteria were patients with missing maxillary anterior teeth (less than 3), patients who were edentulous for not less than 6 months, and patients with good bone quality. Exclusion criteria were patients with systemic diseases such as diabetes mellitus, hypertension, or bleeding disorders; smokers; pregnant women; patients not giving consent; and those with insufficient bone quantity. Institutional ethical consent was obtained prior to the study. All patients were informed about the study in understandable language, and written permission was obtained. The study was conducted by two trained investigators from June 2017 to November 2019.

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A demographic profile of each participant was recorded. For all patients, careful clinical assessment was performed. The current study utilized dental implants with a width of 3.0–4.2 mm and a length of 10–13 mm. We used Noble Biocare dental cylindrical-shaped dental implants for all cases but did not use bone graft. Implant screws were made tight with a manual torque wrench to make sure a torque of 40 N cm. Primary implant stability was calculated using Periotest® M handheld apparatus prior to load.

The periotest device was utilized for measuring the stability of implants in the second stage. During the second stage, healing posts were attached to the implants, and the patient was seated so that the jaw would be in a horizontal posture to the floor. The probe was leveled at a right angle to the post, and its contact was made as close to the bone crest as possible. All of the implants were tested in lateral directions. Readings taken by the device registered the same values at three consecutive times. Patient’s prostheses and over dentures were removed during the evaluation. A periapical radiograph was taken in each case. A radiographic value (RV) over dentures were removed during the evaluation. A periapical radiograph was taken in each case. A radiographic value (RV) from 0 to 10 was assigned to each implant. A value of 0 was given to implants with no radiographic crestal bone loss, and a value from 0 to 10 was assigned to each implant. A value of 0 was given to implants with no radiographic crestal bone loss, and a value from 0 to 10 was assigned to each implant. A value of 0 was given to implants with no radiographic crestal bone loss, and a value from 0 to 10 was assigned to each implant. A value of 0 was given to implants with no radiographic crestal bone loss, and a value from 0 to 10 was assigned to each implant.

Table 1 presents that of 60 patients, 54 patients had periotest values (PTVs) between −0.8 and 0 at placement which decreased to 50 after 3 months. After 1 year, the number further decreased to 44. There were six patients having PTVs between +1.0 and −9.0 at placement which decreased to 0 after 1 year. No patient had PTVs between +10.0 and −50.0 at placement which increased to 4 after 1 year.

Table 3 demonstrates that 11.5 mm-long implants had the highest mean periotest value (0) after placement, whereas 10 mm-long implant had a value of −0.31 and 13 mm had a value of −0.48. After 1 month, 10 mm had a value of 1.23, 11.5 mm had a value of 0.32, and 13.0 mm had a value of −0.24. After six months, 10 mm had scores of 1.78, 11.5 mm had scores of −0.4, and 13.0 mm had scores of −0.41. After 1 year, 10 mm had scores of −0.54, 11.5 mm had scores of −0.51, and 13.0 mm had scores of −0.48.

Table 4 shows that there was a negative correlation between implant length and the mean periotest value. The dissimilarity was nonconsiderable (p value > 0.05).

Table 5 indicates that, at placement, maximum periotest value (−0.11) was seen with implant diameter of 3.0 mm, and minimum value (−0.42) was seen with implant diameter of 3.5 mm. After 1

**Table 1: Demographic profile of patients**

| Gender   | Number | p value |
|----------|--------|---------|
| Male     | 28 (46.7%) | 0.81    |
| Female   | 32 (53.3%) |         |
| Age groups (years) |       |
| 18–28    | 24 (40.0%) | 0.01    |
| 29–38    | 16 (26.6%) |         |
| 39–48    | 12 (20.0%) |         |
| 49–58    | 8 (13.3%)  |         |

**Table 2: Periotest value of dental implants at different interval of time**

| Time interval | −0.8 to 0 | +1.0 to 9.0 | +10.0 to 50.0 | Total |
|---------------|-----------|-------------|---------------|-------|
| At placement  | 54        | 6           | 0             | 60    |
| After 1 month | 54        | 4           | 2             | 60    |
| After 3 months| 50        | 6           | 0             | 56    |
| After 6 months| 48        | 0           | 4             | 52    |
| After 1 year  | 44        | 0           | 4             | 48    |

**Table 3: Distribution of implant length by the mean periotest value**

| Implant length | Time interval | 10 mm | 11.5 mm | 13.0 mm | Total |
|----------------|---------------|-------|---------|---------|-------|
| At placement   | −0.31         | 0     | −0.48   | −0.3    |       |
| After 1 month  | 1.23          | −0.32 | −0.24   | 0.72    |       |
| After 3 months | 0.46          | −0.32 | −0.21   | −0.04   |       |
| After 6 months | 1.78          | −0.4  | −0.41   | 1.43    |       |
| After 1 year   | −0.54         | −0.51 | −0.48   | −0.5    |       |

**Results**

Table 1 shows that among the 60 patients, 28 (46.7%) were males and 32 (53.3%) were females: 24 (40.0%) patients were included in the age-group of 18–28 years, 16 (26.6%) in 29–38 years, 12 (20.0%) in 39–48 years, and 8 (13.3%) in 49–58 years. The difference was considerable (p value < 0.05).

Figure 1 indicates that there were 12 patients with 13 × 4.2 mm dental implants, 10 had 13 × 4.2 mm implants, 8 had 11.5 × 4.2 mm implants, 8 had 13 × 3.5 mm implants, 6 had 13 × 3.0 mm implants, 5 had 11.5 × 3.5 mm implants, 4 had 10 × 3.5 mm, another 4 had 10 × 3.0 mm implants, and 3 patients had 11.5 × 3.0 mm implants.
The periotest scores vary from the instrument correlates the contact time with tooth mobility. Periotest has the benefits of contributing to reproducible findings and found that mean periotest values were 13.0 mm (12) implants. Kastala et al. has divided 17 patients into two groups based on the implant type. The primary implant firmness was calculated at the time of implant insertion, and secondary stability was calculated at 3–4 months via RFA device OSSTELL ISQ. There was no statistically significant difference in primary and secondary stabilities. Among mesiodistal stability and implant diameter in MIS seven groups, a positive relationship was p value < 0.05.14 Bilhan et al. and Khalaila et al. assessed the reliability of periotest in measuring implant stability, and they concluded that the periotest has an admirable intra- and interobserver reliability in checking implant stability similar to our results.15,16 Al-Jetai et al. evaluated the efficacy of Osstell™ and periotest in detecting implant stability, and they found that both systems are proving to be sensitive in diagnosing the implant stability.17 We observed that there was an unconstructive association between the implant length and the mean periotest value. We found that implant stability increases as implant length increases, although this was not statistically significant. We also noticed that, at placement, maximum periotest value (−0.11) was seen with implant diameter of 3.0 mm, and minimum value (−0.42) was seen with implant diameter of 3.5 mm. Lowest value of −0.58 was observed in the implant having a smallest diameter of 3.0 mm after 1 year. There was a negative correlation between implant diameter and the mean periotest value. We found that at placement, each implant had maximum stability at the time of insertion, and as the time passes, the stability of dental implants decreases. The main cause of tooth loss in the present study was poor oral hygiene and nonrestorable teeth due to caries. Obagbemiro et al. also demonstrated a negative correlation among the implant length, diameter, and the mean periotest values. There was a directly proportional relationship between implant quality and implant stability.18

Dental implants are routinely utilized in prosthetic treatment for replacing missing few or multiple teeth. Earlier endosseous or root implants were considered best because of high success rate and less patient discomfort when compared to other implants.19 Dental implants are available with different thread shapes, such as standard V thread, square thread, buttress thread, reverse buttress thread, and spiral thread.20 Based on thread shape, there is variation in stress distribution. With V shape or square shape, there is less stress, whereas buttress-shaped thread generates more stress at the implant–bone interface.9 This study was conducted in order to determine the stability of immediate-loaded single implants with periotest. The periotest has the benefits of contributing to reproducible findings by measuring the stages of subclinical mobility.9

In the present study, we included 60 patients requiring dental implants in maxillary anterior region, with age ranging from 18 to 58 years, of which 28 were males and 32 were females. Twenty-four patients were in the age-group of 18–28 years, 16 in 29–38 years, 12 in 39–48 years, and 8 in 49–58 years.

Periotest is intended to assess tooth mobility through detecting the damping capacity of periodontal ligament at first time. The structure of periotest is a hand piece with a built-in metal slug. Periotest calculates the time needed for the tapping head to create contact with the tooth with an accelerometer. The software on the instrument correlates the contact time with tooth mobility. The periotest scores vary from −8 to +50.16. The lower values represent more rigidity. It is affected by both implant size and bone quality.9

Oh et al.13 evaluated the utility of periotest and Osstell Mentor in assessing implant stability on four dogs. PTVs and implant stability quotient (ISQ) were measured at the time of implantation and at 3 and 6 weeks after implantation. The PTV score was inferior, and ISQ score was superior at six weeks. The PTVs of the maxilla were superior to the mandible, and the ISQ values of the maxilla were inferior to the mandible. Based on the new peri-implant bone formation rate (NBFR), the 6-week group illustrated superior bone deposition in contrast to the 3-week group. The NBFR was superior in the maxilla in comparison to the mandible. There was no considerable disparity among PTV and ISQ when compared to NBFR.

We found that maximum patients (12) had 13 × 4.2 mm dental implants followed by 13 × 4.2 mm implants (8), and 13 × 3.5 mm (8) implants. Kastala et al. has divided 17 patients into two groups based on the implant type. The primary implant firmness was calculated at the time of implant insertion, and secondary stability was calculated at 3–4 months via RFA device OSSTELL ISQ. There was no statistically significant difference in primary and secondary stabilities. Among mesiodistal stability and implant diameter in MIS seven groups, a positive relationship was p value < 0.05.14 Bilhan et al. and Khalaila et al. assessed the reliability of periotest in measuring implant stability, and they concluded that the periotest has an admirable intra- and interobserver reliability in checking implant stability similar to our results.15,16 Al-Jetai et al. evaluated the efficacy of Osstell™ and periotest in detecting implant stability, and they found that both systems are proving to be sensitive in diagnosing the implant stability.17 We observed that there was an unconstructive association between the implant length and the mean periotest value. We found that implant stability increases as implant length increases, although this was not statistically significant. We also noticed that, at placement, maximum periotest value (−0.11) was seen with implant diameter of 3.0 mm, and minimum value (−0.42) was seen with implant diameter of 3.5 mm. Lowest value of −0.58 was observed in the implant having a smallest diameter of 3.0 mm after 1 year. There was a negative correlation between implant diameter and the mean periotest value. We found that, at placement, each implant had maximum stability at the time of insertion, and as the time passes, the stability of dental implants decreases. The main cause of tooth loss in the present study was poor oral hygiene and nonrestorable teeth due to caries. Obagbemiro et al. also demonstrated a negative correlation among the implant length, diameter, and the mean periotest values. There was a directly proportional relationship between implant quality and implant stability.18

Table 4: Correlation of implant length by total mean periotest score

| Implant length | Mean periotest | Spearman’s rho correlation coefficient | p value |
|----------------|---------------|--------------------------------------|---------|
| 10.0 mm        | 1.70          | −0.24                                | 0.914   |
| 11.5 mm        | −1.82         |                                      |         |
| 13.0 mm        | −1.06         |                                      |         |

Table 5: Distribution of implant diameter by the mean periotest value

| Time interval | 3.0 mm | 3.5 mm | 4.2 mm | Total |
|---------------|--------|--------|--------|-------|
| At placement  | −0.11  | −0.42  | −0.38  | −0.32 |
| After 1 month | 2.20   | 0.21   | −0.38  | 0.74  |
| After 3 months| −0.52  | −0.28  | 1.14   | −0.02 |
| After 6 months| 1.51   | 2.16   | −0.30  | 1.44  |
| After 1 year  | −0.58  | −0.47  | −0.52  | −0.51 |

Table 6: Correlation of implant diameter by total mean periotest score

| Implant length | Mean periotest | Spearman’s rho correlation coefficient | p value |
|----------------|---------------|--------------------------------------|---------|
| 3.0 mm         | 2.12          | −0.72                                | 0.872   |
| 3.5 mm         | 0.72          |                                      |         |
| 4.2 mm         | −0.64         |                                      |         |
to diameter and length. It was concluded that the periotest is a reproducible and useful method for checking implant stability. There was greatest implant stability in long implants with greatest diameter. The drawback of the present study is small sample size. Different shaped implants were not considered in the study.

**CONCLUSION**

The authors found that there was maximum implant stability in long implants with maximum diameter. Periotest can be utilized for assessing dental implant stability.

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