Original Article

Evaluation of Stability in Short Implants Compared to Standard Implants using Periotest ®: A Pilot Study

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Abstract

Introduction: Among different non-invasive approaches for determining the stability of the implant within the bone is to use a dynamic device called Periotest®. It is designed to provide objective measurement of tooth mobility. The aim of the present study is to evaluate the stress transfer and stability in short and standard dental implants using Periotest® device. **Methods:** This study evaluated 15 short and 15 standard implants for non-systemically compromised patients who were candidates for dental implant. After the implant insertion, the Periotest Value (PTV) index was measured by the Periotest® device in two periods, three month after implant installation when the healing abutment was placed and six months after permanent restoration. The stability was measured by Periotest®, and the obtained numbers were analyzed by the Wilcoxon test. **Results:** The mean values of PTVs in the group of short implants were as much as -1.13 ± 0.91 and -1.46 ± 0.91 before and after loading, respectively. Moreover, the mean values of PTVs in the standard implant group were as much as -1.6 ± 1.12 and -1.8 ± 0.67 before and after loading, respectively. The difference between short implants before and after loading was not significant. Furthermore, the PTVs in standard implants showed no significant difference before and after loading. Also there was no significant difference between short and standard implants at both times before and after loading. **Conclusion:** There is no significant difference between short and standard implants in terms of stability;

therefore, they can be a good alternative to standard implants in atrophic jaws.
Keywords: Periotest®, Short Implant, Standard Implant

Introduction

A typical treatment plan for edentulous patients is complete or partial prosthesis. However, usage of removable prosthesis decreases the power of chewing and perception of the taste. Endosseous implant can be an appropriate option for the treatment of edentulous patients. The success rate of dental implants is associated with bone quality and quantity. Short implants have lately been presented as a novel solution to simplify implant insertion in the alveolar bone and avoid possible harms to vital structures. Implants in the posterior region are usually shorter than anterior implants (1). Nowadays, what has been unique in implant-based therapies is the ability to achieve the proper function, beauty, and contour of restoration despite the problems, such as atrophy and any complication in masticatory system. For this reason, the demand for implant-based treatments is increasing (2). Short implants are regarded as an alternative treatment that decreases the complexity

of the surgery mainly in the posterior of the jaw since bone analysis in these areas results in close proximity to anatomical structures, which may put standard implants in a difficult position. Therefore, considering the wide application of dental implants and the necessity of using short implants (less than 8 mm in length) in atrophic jaws, it is necessary to examine their success rates, compared to long implants as well as bone graft or nerve displacement surgery (which has its own complications) (3). Primary stability during insertion (primary stability) and osseointegration process during recovery (secondary stability) are two crucial elements for the success of the implant. Evaluation of the quality and quantity of the bone and implant surface are generally considered as a vital step by clinicians in the early stages before loading (4). Implant stability is regarded as an important prerequisite in successful implantation. One of the main indicators of the success of osseointegration is the lack of implant mobility (5). In order to achieve the ideal results, it is necessary to make a comprehensive assessment of the patient before implant insertion. This assessment usually begins with the patient's medical and dental history followed by diagnostic radiography (i.e., panoramic and Cone Bean Computed Tomography) and prosthetic examinations (i.e., patient occlusion and edentate area). Since the patient's period of edentulousness can affect the bone density which is connected to the stability of the implant, evaluation of the bone quality before surgery is a prime element in the successful implant therapy (6). The Periotest® device is used to measure the implant stability through a non-invasive way. This device was manufactured by Siemens Germany (Periotest®, Siemens AG, Bensheim, Germany) and originally designed to measure the amount of tooth mobility. The manufacturer claims that this device can determine the mobility of the tooth with a little precision in the absence of pathologic radiographic findings. The range of values measured by the Periotest® in non-moving implants relies on the condition of the surrounding tissues (the bone surrounding successful implants and tissue fibrosis in unsuccessful implants). Due to the fact that the smallest clinical mobility is considered as a symptom of failure, the values measured by the Periotest® are clinically important (4). According to some studies, this device has a high sensitivity to early diagnosis of implant failure during the first surgical procedure and also shows more capacity for assessing the stability of the osseointegration period, compared to radiographic assessments (7). The use of different implant systems with various designs leads to unstable results. According to clinical findings, it seems that this stability will determine the clinical future of the implant. In recent years, because of the widespread usage of dental implants and the necessity of using short implants (less than 8mm in length) in atrophic jaws, it is important to evaluate their success rates in comparison with long implants and bone graft or nerve repositioning.

Periotest® device is an electromechanical device with a sensitive tipper that hits 16 times in 4 seconds to the crown of the tooth with an implant abutment, and the sensitive tip records the tipper bout. The hand piece should be held at a slightly greater angle (1 to 5 degrees) from the perpendicular to the abutment axis .Whenever an implant or a tooth has more mobility, this tipper will have a longer contact with crown or abutment. As a result, it increases the number recorded by the Periotest®, which is called Periotest Value (PTV) (Table I). The PTV ranges from -8 (clinically very stable) to +50 (very mobile) (Table II).

With the help of this tool, the initial stability of the implant in each area and the restoration period are measured without the use of other risky techniques for each individual implant. Periotest® is user friendly and affordable, which provides convenient and practical information on the status of osseointegration and the stability of the implant. The aim of present study is to evaluate the survival and stability rate in short implants, compared to standard implants using the Periotest®.

Materials and Methods

Fifteen patients, 8 women (53%) and 7 men (47%), with a mean age of 41.36 ±10.49 years and an age range of 25–60 years, were selected for the present clinical trial .This clinical trial was conducted in Mashhad Dental School, Mashhad University of Medical Sciences, Iran, during 2018. This pilot study evaluated 30 implants (15 short and 15 standard implants) for non-systemically ill patients who were candidates for dental implant insertion. All implants were inserted on the basis of a suitable treatment plan for each individual depending on the size and quality of the bone. Moreover, any non-surgical procedures that would not fit the patient's needs were avoided in this study. The case group in this study consists of patients with bone loss in posterior regions of mandible (8 to 9 mm bone height on top of the mandibular canal)**.** Bone dimensions were measured with preoperative computer tomography (CT) scans. Exclusion criteria were: 1) untreated periodontitis, 2) general contraindications to implant surgery such as recent myocardial infarction and cerebrovascular accident**,** 3) poor oral hygiene and motivation, 4) uncontrolled diabetes**,** 5) pregnancy**,** 6) extraction sites with less than 3 months of healing, 7) and inflammation in the area intended for implant placement. The study protocol was approved by the Ethics Committee of Mashhad Dental School; Mashhad, Iran with the number of (IR.MUMS.DENTISTRY.REC.1397.025).The present

Assessment of Stability in Short Implants with Periotest®

study is registered in Iranian Registry of Clinical trials with the number of IRCT31600.

All implants were Implantium products (Implantium, Dentium, Korea). It should be noted that informed consent form was obtained from all patients before enrolling in the study, and it was attempted to unify the disturbing variables, such as age and gender in both groups to enhance the credibility of the data. All surgeries were performed by a periodontist. In this study, the PTV index was measured after implant insertion by the Periotest device in two time periods. Firstly, three month after implant installation when the healing abutment was placed, and secondly, 6 months after the permanent restoration was placed and loaded.

Data were analyzed using Shapiro-Wilk test, Independent t-test, Mann-Whitney U test, and Wilcoxon test. A p-value of ≤ 0.05 was considered statistically significant.

Table I. Relationship between the degree of loosening and the Periotest value

Grade of Mobility	Periotest Value
0	-8 to +9
I	+10 to +19
II	+20 to +29
III	+30 to +50

Table II. Interpretation of the values obtained from the Periotest®

Interpretation	Periotest Value
Good osseointegration, the implant can be loaded	8 to 0-
The need for clinical evaluation, loading is not possible in most cases	1 to +9+
Inadequate osseointegration, loading cannot be performed	10 to +50+

Results

The gender distribution in the study groups was quite similar (P=1.00). The mean age in the short implant group was 40.4810±10.13, with 42.24±10.97 years in the long implant group, with no significant difference (P=0.556). Table III depicts the descriptive information about short and standard implants before and after loading. The mean±SD values of the PTVs were -1.13±0.91 and -1.46±0.91 before loading the short implants, as well as -1.6±1.12 and -1.8±0.67 before loading the standard implants, respectively. There were no statistically significant differences between them in this regard. The smallest PTV measured in the short implant group at both times before and after loading was -3, and the highest was 0. Furthermore, the minimum and maximum PTVs in the standard implant group before and after loading were as much as -4 and 0, as well as -3 and -1, respectively. Moreover, no significant difference was found between short and standard implants before and after loading in this regard.

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Table III. Comparison of the inter-groups and intra-groups regarding Periotest values

	Short Implant		Standard Implant		P-value
	Mean±SD	Range (Min-Max)	Mean±SD	Range (Min-Max)	
Before	-1.13±0.91	(-3 0)	-1.6±1.12	(-4 0)	0.222[***]
After	-1.46±0.91	(-3 0)	-1.8±0.67	(-3 -1)	0.179[*]
P-value	0.298[**]		0.559[**]		

SD: Standard Deviation, Min: Minimum, Max: Maximum *: Mann Whitney U test, **: Wilcoxon Test, ***: Independent t-test

Discussion

In the present study, there was no significant difference between short implants before and after loading. Moreover, the PTVs in standard implants revealed no significant difference before and after loading. Bruggenkate et al. (8) investigated 253 6-mm short implants in a 6-year interval. In this survey, 7 implants were removed, of which 6 implants were maxillary and 1 was mandibular. The results of this study were comparable to the findings of studies that utilized longer implants. Despite the favorable results, it is better to use a combination of short and long implants for insufficient bone density, especially in maxillofacial bone. Since all implants in the present study were inserted in the mandible, the results of the aforementioned study cannot be compared with the findings of the current study. In a study carried out by Van Assche et al. (9), the combination of short and long implants was evaluated for overdenture in 12 patients. Totally, six implants were inserted for each patient. Moreover, the most distal implant of each quadrant was 6 mm short and the middle long implant was 10 to 14 mm in length. The stability of implants was measured by Periotest and Osstell. In this study, a short implant was failed within two weeks after surgery, which can be due to loosening caused by a temporary prosthesis. Moreover, in the first year after loading, the average bone loss was 0.3mm in short implants and 1.3mm in long implants. In the second year,

these values were 0.3 and 0.2 mm, respectively. The stability values of the short and long implants were 67 and 70 at the insertion time, as well as 75 and 78, respectively, one year after the

Insertion. All implants were stable enough after two years of follow up. There was no significant difference among the implants with different lengths in terms of the stability over a period of two years. This study investigated the status of implants for overdenture in a combined condition (short and long). In addition, this study was performed on maxilla and used both standard and short implants, which is similar to our study. It seems that loading short implants along with standard implants will result in a more efficient distribution of forces and a greater chance of success. In the same vein, Felice et al. (10) conducted a study on 28 patients with complete denture and maxillary atrophic ridges. Subsequently, they were divided into 2 groups including short implants of 5 to 8.5 mm and implants longer than 11.5 (which received autogenous bone graft from iliac crest). A 5-month follow up was performed in this study, and a sinus elevation surgery failed due to an infection. One implant in the retention recipient group and 2 implants in the short implant group failed. The complications due to more surgery were remarkably observed in the recipient group. It seems that short implants are suitable, cheap, and faster

replacements than long ones for insertion into restored mandibles by bone graft. In this study, the results of short implants with long implants along with sinus lift surgery in the maxilla have been compared. Although all the implants were inserted in maxilla, the results were consistent with the findings of the present study suggesting the similarity of the stability of short implants to that of the standard implants. Similarly, Grant et al. (11) inserted 335 8-mm implants for 124 patients. Of these, 331 osseointegrated implants successfully occurred. The success rate of the 8-mm implants inserted in mandible was 99% from the early stages of surgery to 2 years. Therefore, placement of short implants in the posterior mandible with a decreased height is a predictable method. In this study, the success rate of implants was investigated qualitatively, and the implants had different widths. The results of our study confirm the conclusion of this study which indicates the reliability of short implants in mandible. Anitua et al. (12) performed a study on 661 patients who received 1287 short implants with a length of less than 8.5 mm in both jaws. In this study, only 9 out of 1287 implants failed. Moreover, in this 7-year study, the success rate of implants was predicted at 99.3%. The results of this retrospective survey demonstrates that treatment with short implants can be secure and foreseeable under controlled clinical conditions. This study was retrospective and considered the osseointegration as the only criterion for treatment success; however, the present study compared the numbers measured by Periotest® and did not consider the implant failure. Nevertheless, this study confirms the clinical use of short implants as a successful treatment which is consistent with our results. In the same line, Misch et al. (13) carried out a study on 273 patients and 745 implants with a length of shorter than 10 mm in the posterior areas of patients with partial edentulous. The success rate of implants in this retrospective study was determined at 98.9%. Short implants can be predictably used as abutments of fixed posterior prosthesis in partial edentulous patients. In this study, as in previous studies, the evaluation of implants was qualitative and a comparison between short and long implants has not been performed. Al-Hashedi et al. (14) reviewed two groups of Bicon implants (6 or 8 mm) and Ankylos implants (8 mm) in the posterior mandible. The measurements were carried out at loading time of 2, 6, and 12 months after loading. There was no significant difference between the two groups in terms of clinical and radiographic findings; however, the PTVs in the Ankylos group were significantly lower. In this follow up, 12 clinical and radiographic results of tissues surrounding the implant were desirable, and a marginal bone size of 0.1 mm was observed. Furthermore, soft and hard tissue changes around the implant were similar in both groups; however, the Ankylos group showed higher stability at measurement times. There was no significant clinical difference between the two implant systems. According to this study, the use of short implants in the mandible with partial edentulous has predictable results, and its success rate is 100% in the 12-month follow up after loading. In this study, two types of short implants have been investigated; however, they have not been compared with long implants. Esposito et al. (15) evaluated whether or not 5-mm short dental implants could be used as an alternative treatment to augmentation with an organic bovine bone and insertion of at least 10-mm long implants in posterior atrophic jaws. Overall, 15 patients with bilateral atrophic mandibles and 15 patients with bilateral atrophic maxillae (4 mm to 6 mm bone height beneath the maxillary sinus) and bone thickness of at least 8 mm were taken part in this study. Subsequently, they were randomly divided based on a split-mouth design to receive one to three 5-mm short implants or at least 10-mm long implants in an augmented bone. Implants were inserted after 4 months, submerged, and loaded after another 4 months with temporary prostheses. The 5-mm short implants attained identical outcomes three years after loading same as longer implants in the augmented bone. Short implants might be a desirable option to vertical bone augmentation, especially in mandibles, as the treatment is considered faster and cheaper. The results on the reliability of short implants in this study are consistent with those of the present study. The limitations of the current study include the small sample size and inadequate follow-up period. Therefore, larger clinical trials are definitively required with larger sample size to gain more clinical data. Moreover, the periodontist was very expert with all the delivered interventions and this could limit extrapolations of the present results; however, all procedures were tested in clinical conditions.

Conclusion

Short implants could be replaced with standard implants in atrophic jaw since they have less complexity and are faster, cheaper, and safer. They do not differ from standard implants in terms of stability, and they can also avoid complex and often expensive augmentation procedures. Therefore, the need for bone graft surgery or displacement of the nerve in atrophic jaws can be prevented by the use of short implants.

Conflict of Interests

The authors claim that they have no conflict of interests regarding the publication of the study.

References

1. Esfahrood ZR, Ahmadi L, Karami E, Asghari S. Short dental implants in the posterior maxilla: a review of the literature. Journal of the Korean Association of Oral and Maxillofacial Surgeons. 2017;43(2):70-76.

2. Adell R, Lekholm U, Rockler B, Brånemark P-I. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. International journal of oral surgery. 1981;10(6):387-416.

3. Lemos CAA, Ferro-Alves ML, Okamoto R, Mendonça MR, Pellizzer EP. Short dental implants versus standard dental implants placed in the posterior jaws: A systematic review and meta-analysis. Journal of dentistry. 2016;47:8-17.

4. Al-Jetaily S, Al-dosari AA. Assessment of Osstell™ and Periotest® systems in measuring dental implant stability (in vitro study). The Saudi dental journal. 2011;23(1):17-21.

5. Misch C. Progressive bone loading. Dentistry today. 1995;14(1):80.

6. Misch C, editor Progressive loading of bone with implant prostheses. The Journal of dental symposia; 1993.

7. Noguerol B, Muñoz R, Mesa F, de Dios Luna J, O'Valle F. Early implant failure. Prognostic capacity of Periotest®: retrospective study of a large sample. Clinical oral implants research. 2006;17(4):459-464.

8. ten Bruggenkate CM, Asikainen P, Foitzik C, Krekeler G, Sutter F. Short (6-mm) nonsubmerged dental implants: results of a multicenter clinical trial of 1 to 7 years. International Journal of Oral & Maxillofacial Implants. 1998;13(6).

9. Van Assche N, Michels S, Quirynen M, Naert I. Extra short dental implants supporting an overdenture in the edentulous maxilla: a proof of concept. Clinical oral implants research. 2012;23(5):567-576.

10. Felice P, Soardi E, Pellegrino G, Pistilli R, Marchetti C, Gessaroli M, et al. Treatment of the atrophic edentulous maxilla: short implants versus bone augmentation for placing longer implants. Five-month post-loading results of a pilot randomised controlled trial. Eur J Oral Implantol. 2011;4(3):191-202.

11. Grant B-TN, Pancko FX, Kraut RA. Outcomes of placing short dental implants in the posterior mandible: a retrospective study of 124 cases. Journal of oral and maxillofacial surgery. 2009;67(4):713-717.

12. Anitua E, Orive G. Short implants in maxillae and mandibles: a retrospective study with 1 to 8 years of follow-up. Journal of periodontology. 2010;81(6):819-826.

13. Misch CE, Steigenga J, Barboza E, Misch-Dietsh F, Cianciola LJ, Kazor C. Short dental implants in posterior partial edentulism: a multicenter retrospective 6-year case series study. Journal of periodontology. 2006;77(8):1340-1347.

14. Al-Hashedi A, Taiyeb-Ali T, Yunus N. Outcomes of placing short implants in the posterior mandible: a preliminary randomized controlled trial. Australian dental journal. 2016;61(2):208-218.

15. Esposito M, Pistilli R, Barausse C, Felice P. Three-year results from a randomised controlled trial comparing prostheses supported by 5-mm long implants or by longer implants in augmented bone in posterior atrophic edentulous jaws. Eur J Oral Implantol. 2014;7(4):383-395.

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