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The clinical significance of two-level PVT Periotest® measurements – in vivo endosteal implant stability study

Kliniczne znaczenie dwupoziomowego pomiaru wartości PVT Periotestu w badaniu stabilizacji implantów śródkostnych *in vivo*

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Abstract

Introduction. A number of investigations was published with different clinical and scientific approach to Periotest® and Ostell® measurements in the last decade. Attempts were made to assess Ostell® and Periotest® prognostic measurement values in terms of the success of implant treatment as one value or threshold level measurement.
Aim of the study. The aim of this study was to evaluate the clinical usefulness of PTV measurements as a method of secondary implant stability and the quality of implant bone zone assessment.
Material and methods. Thirty two implant fixtures of five different systems were evaluated during prosthetic phase after second stage surgery. The study was conducted using Periotest® (Siemens AG, Benshein, Germany). The following parameters were taken into account: location of an implant in lower or upper dental arch, selection of located supragingivally and occlusally abutment measurement points and length with diameter of the implant body. Abutment measurement points were chosen in two distant clinically accessible locations: on the occlusal free end margin and on the most gingival accessible surface of the connected abutment.
Results. The lowest and highest measured PTV value were -8 and +8. The average of differences between gingivally and occlusally measured PTV values for maxilla and mandible was 2.95 ± 1.6 and 3.33 ± 2.0 respectively.
Conclusions. The use of PTV Periotest® measurements in two extremely distant points on the implant abutment is clinically objective, non-invasive method of assessing implant bone zone quality before functional load. Smaller calculated PTV difference can predict better prognosis for occlusal load planning protocol.

Key words: Periotest®, PTV measurement, implants stabilization.

Streszczenie

Wstęp. W ostatnim dziesięcioleciu pojawiło się wiele publikacji z wykorzystaniem laboratoryjnych i klinicznych pomiarów przyrządami Periotest® i Ostell®. Podjęto próby znalezienia wartości referencyjnej pomiaru przyrządami Ostell ® i Periotest ® do prognostycznej oceny powodzenia leczenia implantologicznego.
Cel pracy. Celem tego badania była kliniczna ocena przydatności pomiaru wartości PTV jako metody oceny wtórnej stabilizacji implantu oraz jakości strefy implant-tkanka kostna.
Materiał i metody. Oceniono trzydzieści dwa implanty pięciu różnych systemów implantologicznych, po drugim etapie chirurgicznym, w trakcie protetycznej fazy leczenia implantologicznego. Badanie zostało przeprowadzone przy użyciu Periotest ® (Siemens AG Benshein, Niemcy). Następujące parametry zostały wzięte pod uwagę: lokalizacja implantu w dolnym lub górnym łuku zębowym, wybór punktów pomiarowych zlokalizowanych na łączniku dodziąsłowo i okluzyjnie, długość i średnica implantu. Zlokalizowane na łączniku punkty pomiarowe zostały wybrane w dwóch różnych dostępnych klinicznie miejscach: na krawędzi dozgryzowej i powierzchni dodziąsłowej zainstalowanego łącznika.
Wyniki. Najniższa i najwyższa zmierzona wartość PTV wynosiła odpowiednio -8 i +8. Średnia obliczonych różnic pomiędzy zmierzonymi okluzyjnie i dodziąsłowo wartościami PTV osobno dla szczęki i żuchwy wynosiła odpowiednio 2,95 ± 1,6 i 3,33 ± 2,0 PTV.
Wnioski. Pomiar wartości PTV Periotest® na dwóch odległych punktach łącznika implantu jest klinicznie obiektywną, nieinwazyjną metodą oceny jakości strefy implant tkanka kostna przed jego funkcjonalnym obciążeniem. Mniejsza obliczona różnica wartości PTV może prognozować lepsze warunki przy planowaniu obciążenia okluzyjnego.

Słowa kluczowe: Periotest®, pomiary PTV, stabilizacja implantów.

Introduction

Clinical significance of Periotest measurements is in the focus of dental clinicians. A number of investigations were published with different clinical and scientific approach of Periotest® and Ostell® measurements in the last decade [1–15, 28, 29]. Attempts were made to assess Ostell® and Periotest® predictive value measurements in terms of the implant treatment success as a one value or threshold level measurement [16–18, 28, 29]. Publications revealed some Ostell® and Periotest® measurements dependence from different features such as implant level positioning, geometry of fixture and length of implant platform to occlusal plane [7, 19, 23]. Some authors pointed out limited clinical value of single measurements of both Periotest® or/and Ostell® method [20, 21, 22, 24].

From clinical point of view the most important issues are in concern with occlusal load guidelines, different prosthetic planning procedure, progressive functional load and short implant concept. Implant-bone zone (IBZ) is the space where functional load forces are dissipating in surrounding macro bone structure through the implant body, its conditioned rough surface and surrounding bone trabeculae. What information comes from Periotest® measurements? Repeated calibrated rod impacts of a constant kinetic energy and electronically recorded collisions results with PTV display is the clinical outcome of this technique. This is the only clinically available true biomechanical force test which allows instrumentally assess the quality of implant–bone zone as a response to direct, mechanical stimulus [25, 26]. It can be characterized as a non-invasive technique with easy clinical access, multiple measurements possibility and clinical interpretation of the results based on the literature and clinician's own experience. PerioTestValue (PTV) clear scale values ranges from -8 to +50. Achieved measurements are interpreted as rigid and durable connection of implant bone zone for PTV from -8 to 0, an decreased bond strength for PTV from 1 to 9 and insufficient osseointegration for functional load with PTV above 10 [27]. All surfaces such as the abutment or prosthesis can be measured, but the rod must make contact at a correct angle and a distance [10].

Aim of the study

The aim of this study was to evaluate the clinical usefulness of two level PTV measurements as a secondary implant stability and the quality as-

Table 1. The results of PTV measurements
Tabela 1. *Wyniki pomiarów PTV w ujęciu tabelarycznym*

Implant number	Implant positions	Measurement point		Calculated difference	Implant length	Implant diameter /system name	
		Gingival	Occlusal				
		PTV	PTV	PTV	mm	mm	
1	25	-0.15	2	2.15	10	3.3	DIO
2	26	0.5	4.67	4.17	8	3.6	DIO
3	27	1	1	0	10	4.5	DIO
4	24	-0.57	4	4.57	13	4	Astra
5	44	-7	-4	3	13	4	Astra
6	34	-5	2.8	7.8	8	3.5	Ankylos
7	22	-1.16	0	1.16	17	3.5	Astra
8	23	-4.83	-2	2.83	17	4	Astra
9	24	-5	-3	2	17	4	Astra
10	45	-6	-2	4	11	4	Astra
11	46	-8	-3	5	13	5	Astra
12	36	-6	-5	1	11	5	Astra
13	25	-4	-1	3	13	3.7	Implant Direct
14	26	-1	4	5	11.5	3.7	Implant Direct
15	37	-5	-4.83	0.17	8	4.5	Q Implant
16	36	-5	-5	0	10	4.5	Q Implant
17	47	-6	-3	3	8	4.5	DIO
18	46	-5.8	-4	1.8	8	4.5	DIO
19	45	-4.5	-2	2.5	10	3.8	DIO
20	14	-1	2.5	3.5	12	3.8	DIO
21	46	-6	-4.29	1.71	10	4.5	DIO
22	24	-5.2	-1	4.2	12	3.8	DIO
23	26	1	6.1	5.1	8	3.8	DIO
24	43	-6	-2	4	14	4.5	DIO
25	44	-5.2	-1.33	3.87	14	3.3	DIO
26	34	2	8	6	8	3.5	Ankylos
27	12	-1	0	1	11	3.5	Astra
28	46	-3	2	5	9.5	3.5	Ankylos
29	47	-4	1	5	8	3.5	Ankylos
30	14	-4.66	-2	2.66	11.5	3.7	Implant Direct
31	47	-4	-2	2	12	4.5	Q IMPLANT
32	46	-2	2	4	14	3.5	Q IMPLANT

sessment of implant bone zone during prosthetic phase treatment.

Method and material

In this study 32 implant fixtures of five different implant systems, after second stage surgery, during prosthetic phase treatment were evaluated. The study was conducted using Periotest® (Siemens AG, Benshein, Germany). The following aspects were taken to account: location of an implant in lower or upper dental arch, selection of abutment measurement points located supragingivally and occlusally, length and diameter of the implant body. Measurement points on the abutment were selected in two different clinically possible location: on occlusal free end margin and the nearest to the gingiva margin available surface of the connected abutment. The measurements were recorded with the following data: implant location, supragingival and occlusal position of PTV measurement, calculated difference between, width, length and the manufacturer of the implant body. All measurements were taken five or more times excluding insignificant values with calculated arithmetic mean (average) and placed in Table 1. The Periotest® handpiece was adjusted with the perpendicular contact angle not exceeding 20 degrees, parallel contact angle not larger than 4 degrees and maintained the rod and the test surface 0.6 -2.0 mm distance according the published guidelines [27]. The relationship of length and diameter of the implant from the calculated PTV difference was plotted.

Results

PTV measured values were shown in Table 1 and illustrated on diagram Figure 1. The lowest and highest measured PTV was -8 and +8. The calculated differences between oclusally and gingivaly measured PTV values extended from 0 to 7,8 PTV and were illustrated on Figure 2. The average of differences between gingival and occlusal PTV values for maxilla and mandible was 2,95 ± 1,6 and 3,33 ± 2,0 respectively illustrated on Figure 3. The falling implant diameter and length was in relationship with growing PTV difference which was presented on Figure 5.

Discussion

PTV values measured for implants in the alveolar part of the mandible are more negative on average the values measured for the maxilla which confirms better quality of the implant bone zone and reflects anatomical conditions.

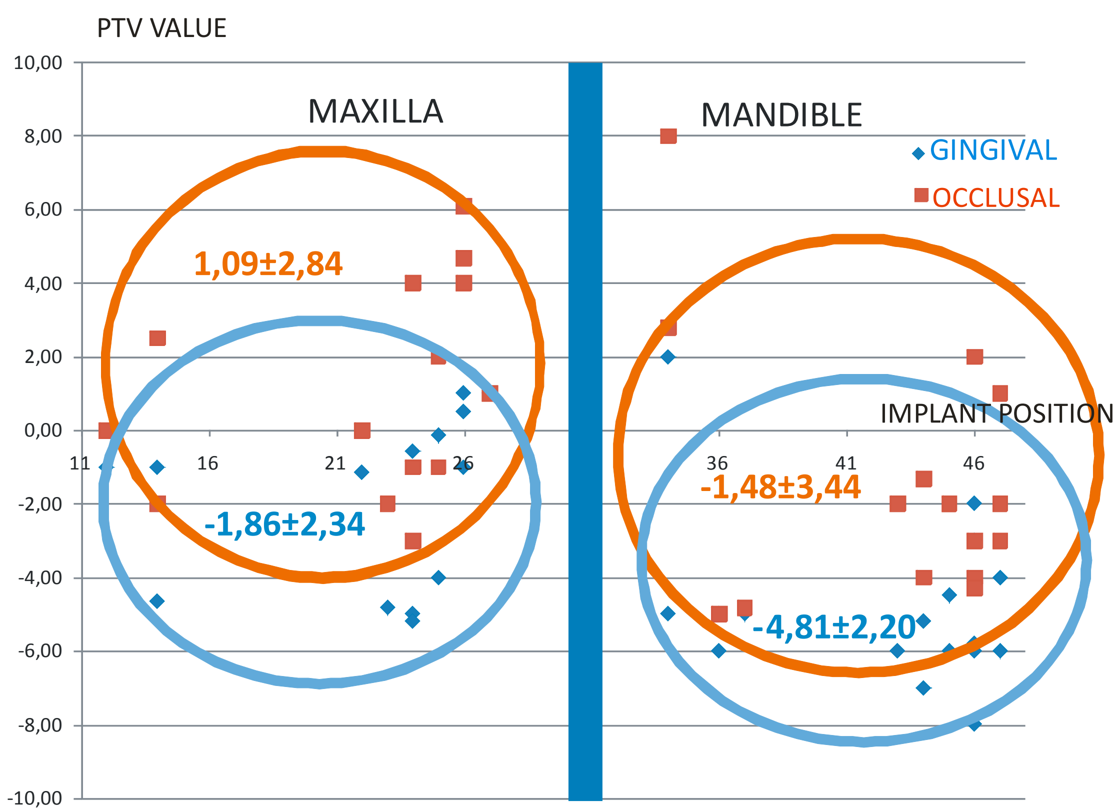

Figure 1. Measurements results. The vertical axis y shows PTV Periotest values, the horizontal axis x shows implant position. Gingival – measurement point, occlusal – measurement point. In circles – average measurments values with standard deviations

Rycina 1. *Wyniki pomiarów. Oś pionowa y – wartość PTV Periotestu, oś pozioma x – położenie implantu. Gingival – pomiar w punkcie przydziąsłowym, occlusal – pomiar w punkcie dozgryzowym. W okręgach – wartości średnie pomiarów z odchyleniem standardowym*

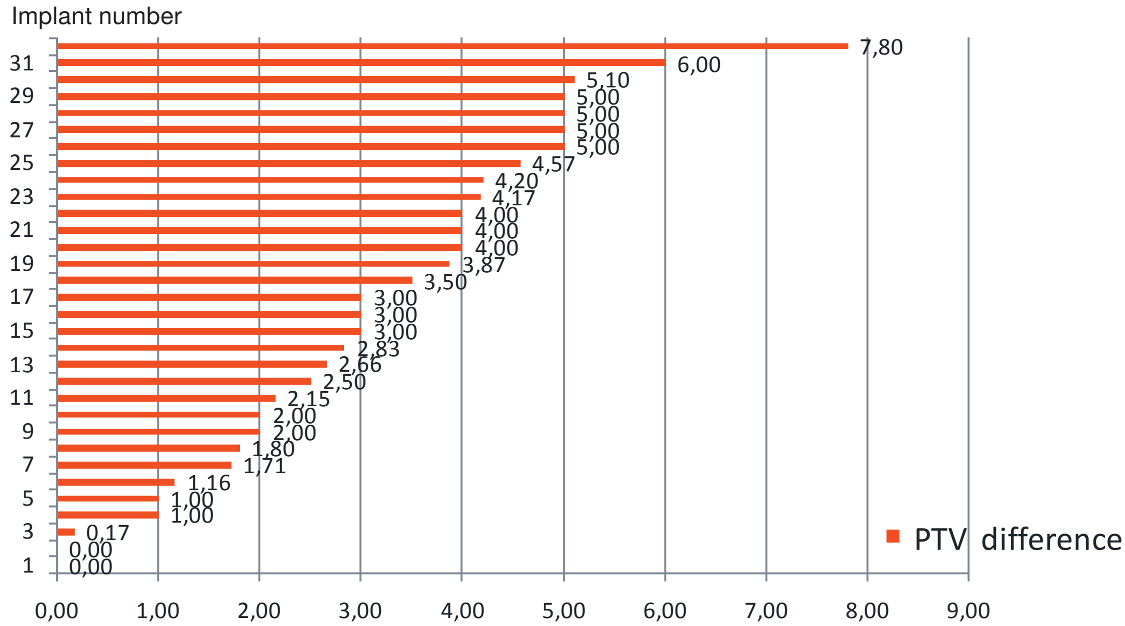

Figure 2. The calculated difference between the measured occlusal and gingival PTV value of tested implants in an increasing order

Rycina 2. *Obliczona wartość różnicy pomiędzy zmierzoną dozgryzową i dodziąsłową wartością PTV badanych implantów w ujęciu narastającym*

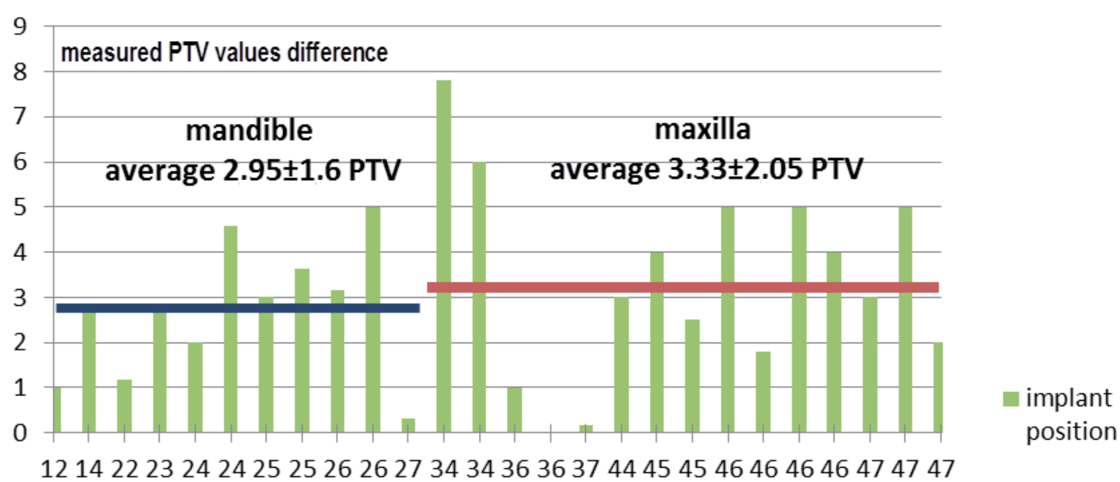

Figure 3. The measured PTV values difference average of tested implants for mandible and maxilla

Rycina 3. *Średnia różnic mierzonych wartości PTV badanych implantów dla żuchwy i szczęki*

Measured values illustrated on diagram Figure 1 have shown that PTV values, although obviously higher for the maxilla than for the mandible, overlapped also to each other. The gingival measurements were more negative in value than occlusal ones although some measurements were nearly of the same value. All implants were clinically stable and accepted for prosthetic reconstruction after x-ray examination. These findings show that approach with one sharp threshold level of PTV measurements cannot be enough for clinical implant stability success evaluation or long term good prognosis of implant treatment. This was reported by numerous study available in literature [1–15, 20–27]. Evaluating the condition of IBZ through measurements performed in different points of time is another option but it prolongs the decision making process. The other possibility is taking measurements on two different levels on the abutment and calculate difference between them. The diagram Figure 1 shows a wide span of this difference from 0 to 7.8 PTV. What is the clinical evaluation of this finding? One example from this study was taken to illustrate it. Two different Astratech® implants with Atlantis® abutments located in position 45 and 46 were taken. Figure 4. Bone

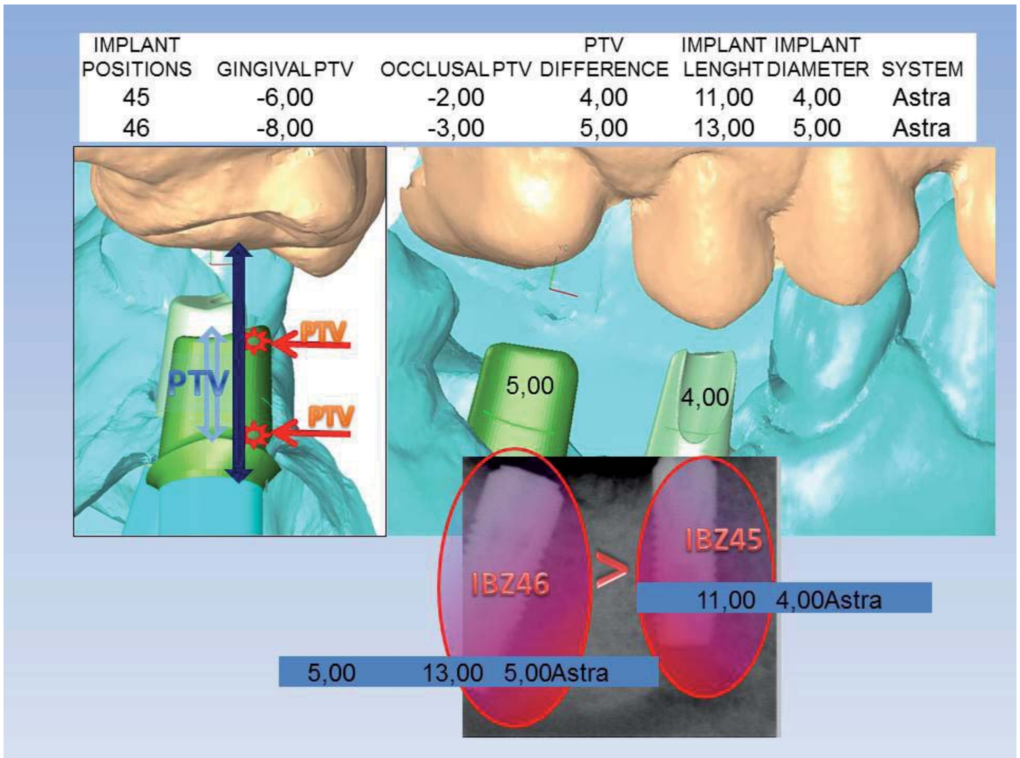

Figure 4. Two different Astra implant measurements (13/5 mm and 11/4 mm). IBZ – implant–bone contact zone

Rycina 4. *Przykład kliniczny pomiaru na dwóch różnych implantach Astra (13/5 mm i 11/4 mm). IBZ – strefa kontaktu implant–tkanka kostna*

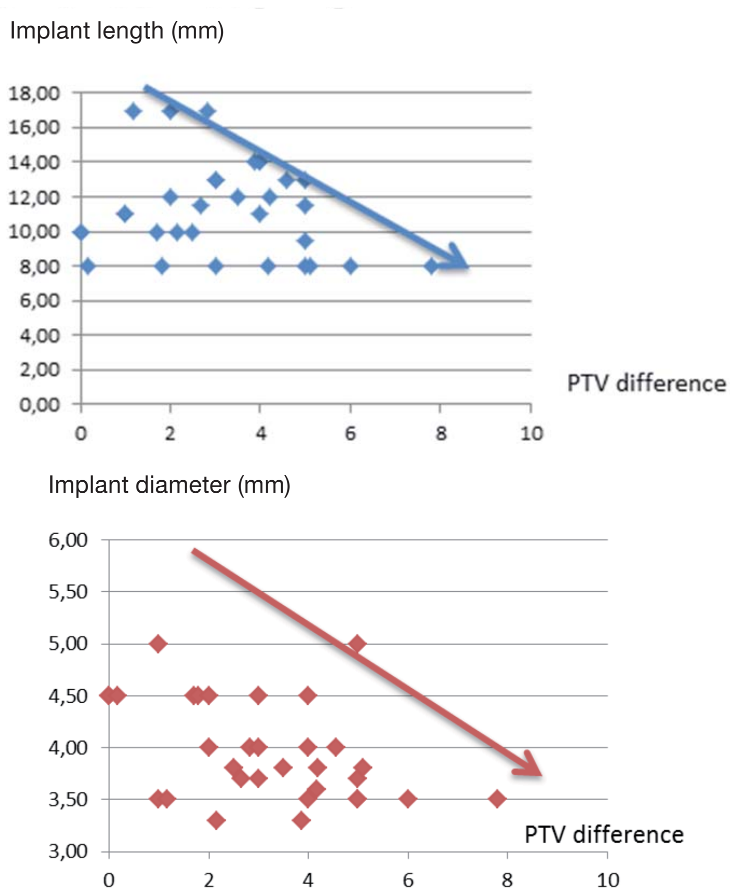

Figure 5. The relationship between length and diameter of the implant and calculated PTV difference

Rycina 5. *Zależność długości i średnicy implantu od obliczonej różnicy PTV* surface area of implant 45 was clearly smaller than that of implant 46 because of its smaller diameter and length. Surprisingly the difference between gingival and occlusal PTV values were favourable for the implant 45 rather than for implant 46 as one can expect. These findings suggest that not only one point measurement but also PTV difference is important and sends additional massage about quality of implant bone zone (IBZ). Because of the macro and microarchitecture (number of trabeculae and presence of thick or thin cortical plates), the bone surrounding implant body is not homogeneous, thus in different clinical situations different clinically measured differences can be expected. As the abutment with implant body can be simplified to double-armed lever, it's point of rotation is located somewhere in the bone part of an implant. It is impossible to clinically adjust the point of rotation but certainly the greater the distance between the occlusion the greater the lever arm and the greater pressure on the bone trabeculae.

From clinical point of view one stage point measurements are of limited value in terms of prognostic ability to bear occlusal load. Two different points, calculated difference between them and recorded distance from bone level to occlusal plane with bone quality x-ray evaluation give a rationale for biomechanical assessment of implant bone interface and clinical success prognosis of prosthetic treatment. Simplifying, the increase of PTV calculated difference represents a decrease of implant bone zone quality.

Growing PTV difference is generally correlated with diminishing diameter and length of implant fixture but as mentioned above and illustrated on the diagram (Figure 5) some unexpected exceptions are present. For the same implant diameter or length very different PTV calculated differences are observed. Applying two level Periotest® measurements and calculate PTV difference between them for stability evaluation of osseointegrated dental implant is clinical outcome of this preliminary study.

More thorough investigations should be done to reveal more detailed relationship between calculated PTV differences, implant geometrical features and biomechanical properties of surrounded bone.

Conclusion

The use of measurements of PTV Periotest® in two extremely distant points on the implant abutment is clinically objective non-invasive method of assessing implant bone zone quality before functional load. Calculated PTV difference gives additional information for relative quality of the implant bone zone assessment. Smaller calculated PTV difference can predict better relative quality of implant bone zone and facilitate decision making process for implant loading protocol choice.

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