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To Evaluate the Reliability of Periotest Device in Assessment of Implant Stability

Abstract:
Osseointegration has been defined as a direct structural and functional connection between ordered living bone and the surface of a load- carrying implant. Close apposition of bone and positive interaction at the molecular level and the interface seem to be prerequisites for long-term survival of load-bearing implants. Early detection of failing implant before fabrication of prosthesis is advantageous to avoid modification or unnecessary repetitions. Identifying fibrous tissue-encapsulated implant predictably at stage 2 surgery has economic, psychological, physiologic and prosthetics benefits. Periotest measurements after second-stage surgery may help the clinician to identify failed implants that are bordered line (i. e., with a very thin fibrous capsule) and those in which digital testing formability radiology may not be sensitive enough to detect problem.
CATEGORY: Dentistry

Key-words: Periotest, Reverse torque, Implant stability, Endosseous fixtures, Marsupialization, Cellular adhesion

Introduction:

Close apposition of bone and positive interaction at the molecular level positive and the interface seem to be prerequisites for long-term survival of load-bearing implants [2]. Furthermore, these indices primarily refer to lack of tight bone contact, such as radiolucency surrounding the implant or slight mobility when tapping it back and forth between the handles of instruments.

In the presence of one or both of these clinical symptoms, the underlying histology consists of a fibrous encapsulation of the implant[4]." This encapsulation by scar tissue implies the risk for marsupialization, a rapid down growth of epithelium along the implant surface until the latter is completely encapsulated. Pocket formation can occur, and this often leads to infectious complications, tissue inflammation, loss of bone, and finally loss of the implant itself.[5]

Since the discrimination acuity of radiographs is limited, they do not always permit the Conclusion that no fibrous or epithelial tissue is interposed between the bone and actual implant surface.[6] Therefore; clinical mobility assessment might be more reliable. Because static mobility tests fail to quantify the damping characteristics of peri-implant tissue, [7,8] dynamic measurements, the clinician faces the problem of interpreting the range from a clinically firm implant to just tangible implant mobility.

An electronic device, the Periotest Medizintechnik Gulden e.K.Eschenweg 364397 Modautal Germany [9,10]which has been reported to be able to measure a the damping characteristics of the periodontium in very reproducible way,

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[1]RANJEET KUMAR CHAUDHARY
[1]Department of Prosthodontics and Crown and Bridge Rama Dental College Hospital And Research Center Kanpur

Address for Correspondence:
Dr. Ranjeet Kumar Chaudhary
Department of Prosthodontics and Crown and Bridge Rama Dental College Hospital And Research Center Kanpur, UP
Email : ranjeet_chaudhary2000@yahoo.com

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could permit the objective discrimination between an implant that has a close bone apposition and one that is fibrously encapsulated. Stability is essential for optimal oral implant function. Osseointegration must be verified at the moment the trans mucosal abutments are connected to the endosseous fixtures and before fabricating the prosthesis. [10,1]Osseo integration is basically a histological concept and only partially clinical and radiological. Several studies have shown that this process consists of a gradual increase in the amount of bone indirect contact with the implant surface over time. The quantity and quality of bone formed at the interface is of utmost importance in determining the holding power of an implant. [11-14]

In the years 1982 Toronto conference on Osseointegration in Clinical Dentistry, clinicians concerned about verifying osseointegration did so by a sound test. It had been reported that a subdued sound upon percussion was indicative of soft tissue encapsulation and failure, and a clear crystalline ring indicated successful integration. The test was conducted by striking an implant mount or abutment with a loosely held mouth mirror handle or dissector.

In year 1990, Albrektsson and Sennerby's [15]reported on this same technique. Various additional instruments such as elevators, scalers and even forceps have been utilized in this capacity.

Although frank movement certainly identifies those implants grossly unstable, this test does little to identify seemingly stable implants that have failed to osseointegrate.

It has long been a clinical observation that some implants that appear successful at second-stage surgery have subsequently failed early in the prosthetic rehabilitative process.

Two studies from highly experienced teams have reported on this phenomenon. Zarb and Schmitt" [16] found "late failures" to occur at a rate of Approximately 3.3% in a patient population largely composed of completely edentulous mandibles.

Naert and Quirynen" [17] published data on partially edentulous patients and included implants throughout the maxilla and mandible with a late failure rate of approximately 2.5%. These percentages become increasingly important because individual practices now provide treatment involving the placement or restoration of hundreds of implants yearly.

However, achieving reproducible and completely parallel (implant-to-film) images at stage 2 surgery is demanding. The most optimum radiographic technique would come to within 0.1 mm of measurable resolution. Because the soft tissue layer that may exist between bone and implant in a non-integrated state is of the magnitude of 0.01 mm, it is obvious that radiographs alone cannot be used to exclude a soft tissue interface in an otherwise seemingly stable implant.

Recent publications concerned with the Periotest device support the contentions that implant length, abutment length, the arch treated and bone density all have significant influence on Periotest values. [18]

This suggests that all failed implants are not routinely identified at stage 2 surgery with this device. The identification of all failed implants at stage 2 surgery is the primary goal of the present study. As is produced in late implant failure, delayed morbidity proves both psychologically and economically problematic to the patient.

Primary stability has been reestablished as a previous clinical requirement to achieve osseointegration. The presence of movements between the surface of the implant and the bone tissue induces a bone resorption that produces fibro integration, in which the implant is surrounded by an interphase of soft or connective tissue, and not bone tissue. [19,20]

Strategies used to improve bone response include increasing the rugosity or the application of bioactive liners, to improve cellular adhesion and thus increase the bone-implant contact surface. [21, 22]

Material and Methods:

Source of Data: Patients visiting Rama Dental College in the department of Prosthodontics.

Method of collection of data:

A total number of 50 dental implants were placed for the study. Patients attending the dental prosthesis.

OPD, requiring replacement of single/multiple missing tooth/teeth with dental implant supported prosthesis were selected. For patients to be a part of study signed formal written informed consent were obtained. Exclusion criteria were presence of any non-controlled systemic disease &/or hormonal disorder, smoking patients, uncontrolled diabetic or hypertensive patients, patients that have received bone graft

during insertion surgery of dental implant, patient with psychological disorder and patients under bisphosphonate therapy.

Diagnostic procedure for each selected cases was carried out which include orthopantamogram (OPG), intra oral periapical radiographs (IOPAR) and study casts. Standardized surgical protocols were followed to prepare the site to place the dental implants. The size of the implant i.e., diameter and length, was based on the diagnostic aids and clinical situations.

a. During stage 2 surgery of dental implant, its osseointegration was checked by Periotest device (Fig.- 2)and the readings obtained are recorded. To rule out any error consecutive 3 readings were obtained and the mean of that was considered as final reading to becompared with other tests.

b. Osseointegration was cross checked by applying 20 Ncm of reverse torque (Fig.- 3)to the osseointegrated implant.

c. Data obtained from above 2 tests are compared to check the reliability of periotest device.

Armamentarium:

A. PERIOTEST-M (model type 3218)(Fig.-1)
Medizintechnik Gulden e.K. GERMANY

B. HI TEC TORQUE WRENCH:

Adjustable from 10 Ncm to 45 Ncm.

IMPLANT NUMBER	PERIOTEST READING			MEAN	REVERSE TORQUE
	FIRST	SECOND	THIRD		20Ncm
1.	-1.4	-0.7	-0.9	-1	negative
2.	-1.4	-1.3	-1.4	-1.36667	negative
3.	1.1	1.2	1.2	1.166667	negative
4.	4.7	4.6	4.1	4.466667	negative
5.	4.7	3.9	4.1	4.233333	negative
6.	-1.6	-1.5	-1.7	-1.6	negative
7.	2.8	2.8	3	2.866667	negative
8.	1.5	1.8	2	1.766667	negative
9.	3	3.1	3.2	3.1	positive
10.	2	1.9	1.5	1.8	negative
11.	1.1	1.2	1.3	1.2	negative
12.	0.4	0.3	0	0.233333	negative
13.	-4.9	-3.9	-4.7	-4.5	negative
14.	0.8	0.5	0.8	0.7	negative
15.	-4.5	-4.4	-4.4	-4.43333	negative
16.	-4.7	-4.1	-5.1	-4.63333	negative
17.	-4.5	-3.3	-3.6	-3.8	negative
18.	-1.9	-2.1	-1.9	-1.96667	negative
19.	-1.7	-2.3	-2.5	-2.16667	negative
20.	-0.2	-1.2	-2.2	-1.2	negative
21.	-3.1	-3.2	-2.4	-2.9	negative
22.	3.5	4.8	5.3	4.533333	positive
23.	6.6	7.2	6.6	6.7666667	positive
24.	-1.6	-1.4	-1.5	-1.5	negative
25.	-1.2	-0.2	-1.2	-0.86667	negative
26.	-0.9	-0.1	-0.1	-0.36667	negative
27.	-2	-2.6	-2.2	-2.26667	negative
28.	7.2	6.5	6.6	6.766667	positive
29.	-1.2	-1.3	-1.1	-1.2	negative
30.	-0.5	-0.6	-0.7	-0.6	negative
31.	0.3	0.4	0.2	0.3	negative
32.	-1.2	-1.4	-1.6	-1.4	negative
33.	-2	-2.1	-2.3	-2.13333	negative
34.	-1.2	-1.3	-1.4	-1.3	negative
35.	-0.5	-0.6	-0.7	-0.6	negative
36.	3.5	4.8	5.3	4.533333	positive
37.	-1.6	-1.4	-1.5	-1.5	negative
38.	6.5	7.2	6.6	6.766667	positive
39.	-1.2	-0.2	-1.2	-0.86667	negative
40.	-0.9	-0.1	-0.1	-0.36667	negative
41.	-2	-2.6	-2.2	-2.26667	negative
42.	-4.5	-4.4	-4.4	-4.43333	negative
43.	-4.7	-4.1	-5.1	-4.63333	negative
44.	-4.5	-3.3	-3.6	-3.8	negative
45.	-1.9	-2.1	-1.9	-1.96667	negative
46.	-4.9	-3.9	-4.7	-4.5	negative
47.	-0.8	0.5	0.8	0.166667	negative
48.	2.8	2.8	3	2.866667	positive
49.	1.5	1.8	2	1.766667	negative
50.	3	3.1	3.2	3.1	positive

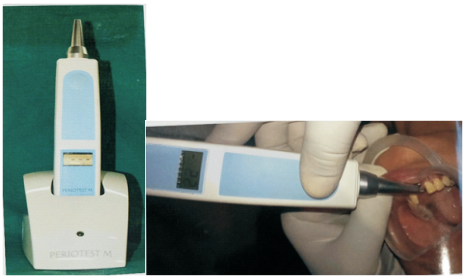


Fig.-1 PERIOTEST-MFig.-2 Periotest device taking reading

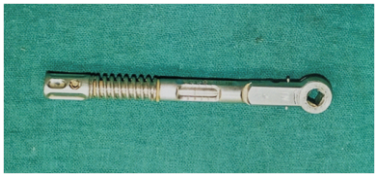


Fig.- 3 Torque ratchet with calibration

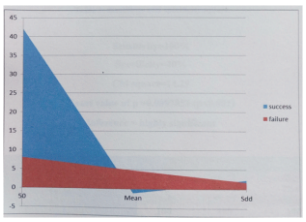
Statistical Analysis:

Statistical package for the Social Science (SPSS) version 21.0, SPSS Inc., Chicago, IL, USA) was used for all statistical analysis. Correlation between the Periotest device and reverse torque test were determined by using Spearman's rho test and $p < 0.05$ was considered statistically significant.

Results:

TOTAL IMPLANTS	SUCCESS	FAILURE
50	42	8
MEAN	-1.08254	4.804167
STANDARD DEVIATION	2.295575	1.74287

Table-1 Success percentage of implant cases



Graph-1 Success percentage of implant cases.

Master Comparison:

Significant Association Between The Groups
Periotest Device

REVERSE TORQUE TEST	PERIOTEST DEVICE		POSITIVE	NEGATIVE	TOTAL
	REVERSE TORQUE TEST	POSITIVE	30	12	42
		NEGATIVE	0	8	8
		TOTAL	30	20	50

TABLE -2 Sensitivity and specificity square

Sensitivity= 100%

Specificity=40 %

Chi square=14.29

Exact value of p=0.0007853 (p<0.001)

Inference= highly significant

	%	LOWER LIMIT	UPPER LIMIT
RISK EXPOSURE	71.43	56.32	82.94
OVERALL RISK	60	46.16	72.41
RISK DIFFERENCE	71.43	57.77	85.09
ETIOLOGICAL FRACTION IN PROPORTION	100	100	100

TABLE- 3 RISK EXPOSURE

Discussion:

Early detection of a failing implant before fabrication of prosthesis is advantageous to avoid modifications predictably or unnecessary repetitions. Identifying fibrous tissue-encapsulated implants at stage 2 surgery has economic, psychological, physiologic, and prosthetic benefits.

Periotest measurements after second-stage surgery may help the clinician to identify failed implants that are borderline (i.e., with a very thin fibrous capsule) and those in which digital testing formability or intraoral radiology may not be sensitive enough to detect problems. Interfacial osteogenesis is a gradual process, and the recommended healing time of 5 to 6 months for maxillary implants and 3 to 4 months for mandibular implants is an empirical routine based on average results of wide clinical experience.

Experiments in rabbits have shown great individual differences in the bone apposition rate at the interface around titanium implants, especially during the first 6 months after implant placement. Even in the same individual, variations in osseointegration occur from site to site. The results of this investigation appear to indicate that the Periotest method can be a very useful clinical parameter to identify, after aregular healing period, those implants that despite being immobile are not stable enough for loading. Because of poor bone quality, immature bone, or not enough bone contact at the interface, full loading of these implants would involve a high risk of load-related failure. On the contrary, leaving them temporarily unloaded or sub loaded could allow the formation of a matureinterface for later use. Periotest values obtained during or immediately following abutment connection can be valuable in developing prosthetic strategies. If most or all of the implants have high PTVs, it would be sensible to remove the transepithelial abutments, leaving the fixtures dormant for an additional period of 3 to 6 months while the patient continued to use the existingdenture with a resilient base. If only one or two implants had high initial PTVs, different strategies could be designed depending on their position and the total number of implants in the arch. If the problematic implant were located in the most distal position, one possible solution would be to attach the framework to all of the abutments available while finishing the prosthesis without including the molars. The frame could be permitted to rest on the abutment of the problematic implant, but without screw attachment. Thus, only compression but no tension or lateral stresses would be transferred. The other alternative would be to remove the abutment of implant temporarily so that no load whatsoever would be applied to that implant.

If two or more implants were in an uncertain condition and it were not possible to design a shorter temporary fixed restoration, a choice almost always available would be to place an over denture on the stable fixtures while the problematic implants stayed dormant for an extended period of integration. The manual tapping of splinted implants only gives an empirical value that does not reflect the situation of individual abutments. Since the gold alloy used in prosthesis attachment screws is harder than the unalloyed titanium, repeated tightening and untightening of the gold screws would cause the threads to wear. This is one reason for recommending that prostheses supported by implants not be removed for routine examinations. The procedure does prevent the Periotest method from being useful for ordinary longitudinal follow-up. Nonetheless, if it is assumed that the load-related bone remodelling process occurs mainly during the first year of function, further Periotest measurements could be made at the end of this period before the access holes were permanently sealed. Lower PTVs would indicate a corticalization of the surrounding bone but whether to load or not is a big question which should be answered and my study is not having significant values and questions arises on the Periotest reading.[24]

Evaluating the damping characteristics of periodontal tissues surrounding osseointegrated implants ad modumBrånemark

in the mandible indicates PTVs between -4 and +2, which is lower than the average values for natural teeth.

The mandibular canines, for example, range between -1 and +4, with a mean of +2.2. Considering the fact that Brånemarkosseointegrated implants predictably achieve bone apposition to the electron microscopic level, the absence of a periodontal ligament logically leads to higher damping values. Titanium has a Young's elasticity modulus of half that of stainless steel, which is 200 GN per m^2, but still is 10 times that of bone (10 GN per m^2). The mandibular bone is known to be linearly elastic but anisotropic and inhomogeneous. Taking into account the mechanical properties of the metallic components, the bone and the interface, calculating a model to evaluate the damping characteristics of the peri- implant tissues is beyond the boundaries of present knowledge. However, the small range of the Periotest measurements achieved in this rather large group of subjects with mandibular osseointegrated implants offers promising clinical perspectives. Indeed, for implants in the maxilla, where a peri-implant radiolucency and clinical mobility indicated non integration, much higher PTV values were obtained and same results were found in my study also. Maxillary implants showed higher values and mandibular lower.[25]

In early experience with reverse-torque testing, there was hesitation to apply torque values greater than 10 Ncm, especially to implants being tested in the maxilla for fear of removing "successful" implants. Unfortunately, this tentative approach provided little more clinically relevant than previously utilized verification tests.

In our experience, it has been found that fibrous encapsulated implants testing stable at 10 Ncm later removed by increasing the force to 20 Ncm had bone cores in their T chambers. This observation confirmed the fact that forces greater than 10 Ncm was required to physically break this bone core in stable, yet non-integrated, implants. It was hypothesized that some of the early implants, all of which were successfully tested to a maximum of 10 Ncm, would have been identified as failures with 20 Ncm of reverse-torque force. The protocol beginning in 1994 was been modified so that all implants are reverse-torque tested to a minimum of 20 Ncm, with larger- diameter implants (5.0 and 6.0 mm) being tested to 32 Ncm.

Since 1994, only one late failure has occurred with 128 implants tested to these limits. The purpose of a clinical verification standard for osseointegration grows out of the economic, psychologic and practical clinical needs of patients and clinicians to determine as soon as possible after placement whether an implant is integrated. Thus, a test for osseointegration is actually a test for non-integration. The clinician needs to identify failed implant(s). The test should be objective and easy to administer and should use available armamentaria, be as definitive as possible within the available knowledge base, and possess an adequate level of safety so that damage to the implant interface does not occur. The reverse-torque test has been designed to identify fibrous encapsulated implants at the earliest possible stage. The elimination of a failed implant at second-stage surgery by an objective standard lead to improved patient management. Taking this article as reference the study used 20 Ncm of reverse torque test as standard protocol for my study.[23]

In accordance with authors such as Sullivan, Jividen and Carr our main objective when performing the reverse torque test was to identify non-integrated dental implants as early as possible, before the restoration phase, through an objective method for clinical verification that is easy to perform, with readily available tools, and with a proper level of safety that will not damage the bone-dental implant interphase. Based on previous studies, such as Carr's in 1995.

Who suggested, knowing the risks of data inferred from animals compared to humans, a recommended measurement of 35 Ncm when placing the prosthetic component, which has been confirmed and established by every commercial brand as the safety margin for most implants at the time of their prosthetic connection. I support my study on the application of a 20-Ncm reversetorque, as a reliable measure under the conditions of our study. Also, in accordance with the results of researches performed on reverse torque on humans, such as Sullivan's, who established that a 20Ncm reverse torque on low density bones is a reliable measurement on cone-shaped Tiimplants, and authors such as Johansson and Albrektsson, who defined that once the dental implants are osseointegrated, the minimum reverse torque required to dislodge Ti implants with treated surface was 116 Ncm, the measurement of 30 Ncm was confirmed as a predictive measure."
[26]

In the study conducted, reverse torque test is taken as control and periotest device as the devices to be tested for its reliability. Results obtained were, out of 50 implants examined 42 implants were successful and 8 cases fail to osseointegrate. These 42 cases have a mean of periotest reading of -1.08254 with a standard deviation of 2.295575. These 8 cases showed a mean of Periotest reading of 4.804167 with a standard deviation of 1.74287.Gender distribution of the study was 27 implants were placed in males with a mean of 0.092593 and standard deviation of 3.245633. [23] implants were inserted in females with a mean of - 0.41449 and standard deviation of 2.962711. Nothing significant was found in male and female distribution of the study.

Right side and left side implant cases are individually compared for the validity of the Periotest device reading. Right side implants cases having mean of 0.17 and left side implant cases having mean of -0.86.

While the study was done, a finding noted was age related success percentage of the placed implants. This was in line with the study done in Japan by various scholars which stated that age- related risk factors for the success of dental implants. In dental implant treatment, chronological age by itself is suggested as one of the risk factors for success, but it would not be a. In general, reserved capacity of bone and soft tissue make it possible to establish osseointegration in the long run. Rather than aging itself, the specific nature of the disease process, such as osteoporosis or diabetes, and local bone quality and quantity at the implant site, mostly related to aging, are more important for successful dental implant treatment.[28]

Another interesting fact that came to know accidentally while doing study was that all the failures were at right maxillary region and all failures were of vegetarian individuals. No study was found in google search, google scholar, pubmed and various other search engines which were correlating with the finding of the study done.

In the study with a time period of 6 months, 50 implants cases were examined at stage 2 surgery for its osseointegration by reverse torque test and Periotest device. Master comparison was made between Periotest device reading and reverse torque test, results in sensitivity of 100% with exact p value of 0.0007853 (<0.05) which is highly significant but specificity of the test is only 40% which is questionable for device's reliability.

Conclusion:

In the study, 50 implants were checked for osseointegration with two different methods i.e. Periotest and reverse torque test. After statistical analysis the result obtained showed that,

Of the total 50 implants 42 of the implants were successful as showed by the reverse torque test.

Of the total 50 implants, 30 were successful as per Periotest device i.e. values between-8.0 to 0.0.

. Out of 42 successful implants cases (as shown by reverse torque test), 12 cases were shown by Periotest as non-osseointegrated.

Out of these 12 cases, 8 cases showed a near to negative readings (0.0 to 1.0) but 4 cases showed high positive readings (3.0 to 7.0) which creates questions on the reliability of Periotest device.

Thus, it is concluded that Periotest device is not 100% correct and furthers studies with large size are required.

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