Original Article

Evaluation of implant stability and crestal bone loss around the implant prior to prosthetic loading: A six month study

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Context: Dental implantology is the state of the art technique to replace missing teeth. Crestal bone loss along implant surface jeopardizes its longevity and success of treatment. **Aims:** This study evaluates the implant stability and the crestal bone loss along the implant surface six months after the implant placement, but before prosthetically loading it. **Materials and Methods:** 100 two-stage implants were placed in 56 patients. Digital OPG was taken on the day of implant placement. After six months, at the time of second stage surgery, the implant stability was evaluated by the Periotest instrument. The crestal bone loss on the mesial and distal side of the implant was evaluated on digital OPG. **Results:** Six months after the implant placement, Periotest evaluation showed a mean of 1.9, which indicated that implants were well osseointegrated and stable. Radiographic evaluation on digital OPG showed a mean crestal bone loss of 0.6mm on the mesial side of implant and 0.9 mm on distal side of implant. **Conclusions:** Even before prosthetically loading the two-stage implant, crestal bone loss of 0.6 to 0.9mm occurred around the implant. The smooth polished collar design of the implant may have contributed to crestal bone loss.

Key words: Implants, collar design, crestal bone loss

INTRODUCTION

Various methods of replacing missing single or multiple teeth, have been developed. Endosseous implants have come up in a big way to resolve this problem. It has become an acceptable alternative to the traditional prosthodontic treatment. Branemark's studies of over 15 years with 90% success, as reported in Toronto Conference in 1982,[1] initiated the present breakthrough in implantology. Many implant designs have been developed by various companies to achieve greater degree of osseointegration. One of the major concerns has been the amount of crestal bone loss along the implant surface, as it jeopardizes the longevity and success of the implant prosthesis. Crestal bone loss has been attributed to implant design, local bacterial colonization, biological width and mechanical stresses acting on the crestal bone around the implant. Crestal bone loss of upto 1mm during first year of implant service and thereafter annual bone loss of 0.1 mm, has been accepted.

Various implant crest modules or neck collar designs are being studied and proposed to reduce crestal bone loss. Many of the implant systems have a polished collar design to aid in reducing plaque accumulation and to promote biologic seal around the implant collar. Such collar design may itself be contributory to crestal bone loss. Prosthetic loading of implant may aggravate the crestal bone loss, initially. But how much bone loss would occur before prosthetic loading in two-stage implants, needs further evaluation.

Keeping this in mind, a study was undertaken to evaluate implant stability and crestal bone loss, occuring six months after the implant placement, but before prosthetic loading.

MATERIALS AND METHODS

An invivo study was undertaken to evaluate the implant stability by Periotest and crestal bone loss on the mesial and distal side of the implant, by digital OPG at the end of six months after placing the implants, but before prosthetically loading it.

The implants used were Pitt-Easy Bio-Oss (Oraltronics, Bremen, Germany), which are two-stage, root-form, TPS coated, pure Titanium implants. Diameters of implants were 3.25, 3.75, 4.00 and 4.9 mm. The implant lengths were 8, 10, 12 and 14 mm. 100 implants were placed in 56 selected patients (41 males and 15 females, 25-50 year age group), to replace one or more missing teeth in maxilla/mandible. The implant size was selected by using the manufacturer's X-ray indicator stencil on OPG and study casts. An osteometer was used under topical anesthesia to determine bone width. Crestal incision was given for full thickness flap reflection, to expose the implant site. After marking the implant site by surgical stent, pilot drill was used, followed by twist drill, 2-caliber and final drill upto the decided depth. The implants were inserted first by using finger key, followed by cardanic ratchet key. The implants were placed at the level of alveolar crest. A cover screw was placed to close the opened implant site. The flap was closed with tight sutures to achieve water-tight closure. The patient was prescribed antibiotics and analgesics for one week, post-operatively. A Digital OPG (Trophy, France) and an IOPA X-ray was taken on the day of implant placement, one hour after the surgery. Patients were placed on periodic review.

After six months of implant placement, implant stability was evaluated by Periotest instrument (Periotest S 3218, Medizintechnik, Gulden). Titanium abutments were screwed on to the implants. The Periotest handpiece sleeve was kept horizontally at right angle to the long axis of implant, 0.5 mm away from the abutment. The instrument was activated and readings noted. Interpretation of Periotest values was as per the manufacturer's instructions. The range of Periotest values is -8 to +50. Negative values are indicative of good stability and osseointegration. Values between 0 to +9 require clinical examination and values above +10 mean that the implant is not well osseointegrated. Three Periotest measurements were taken of the same implant at the same time and mean of three values was recorded.

Crestal bone loss was measured on digital OPG taken on the same machine, which was used for digital OPG at the time of implant placement. The distance between the top of the implant and the level of crestal bone (first bone to implant contact) along the implant surface on mesial and distal side was measured on the OPG machine monitor, using its software. The measured value was auto-corrected by the in-built software for radiographic magnification factor. Values obtained were upto one unit after decimal.

Periotest and crestal bone loss values were tabulated and analyzed.

RESULTS

Out of 100 implants, 07 failed. Hence, 93 successful implants were evaluated, six months after surgical implant placement. Implant stability and degree of osseointegration was evaluated by using Periotest. The crestal bone loss on the mesial and distal side was evaluated on digital OPG.

The readings observed of the Periotest value and the digital OPG were tabulated in Table 1.

Table 2 shows the mean values of the Periotest Values and crestal bone loss on the mesial and distal sides. The average Periotest Value was -1.9, which denotes substantial stability and degree of osseointegration. The range of Periotest values was -8 to -1. Negative readings denote higher stiffness and higher degree of osseointegration. The average crestal bone loss on the mesial side of the implant was 0.6 mm and on the distal side was 0.9 mm. at the end of six months, even before prosthetic loading. The range of crestal bone loss on the mesial side was 0-1.0 mm and on the distal side was 0-1.2 mm.

DISCUSSION

This study was undertaken to observe the implant stability and the amount of crestal bone loss, occurring at the end of six months after placing the implants, before loading it prosthetically. There is a direct correlation between implant stability and crestal bone loss. Greater the crestal bone loss, lesser the implant stability. 100 implants were placed in 56 selected patients. 07 implants failed before the second stage surgery to relocate the implants

The implants used in this study (Pitt-Easy Bio-Oss, Oraltronics, Germany) were two-stage, root-form, threaded implants. Implants were made of pure Titanium with TPS coating, except at the collar region of the crest module. The crest module collar had 2mm of smooth polished parallel surface.

The implant stability was measured by Periotest instrument. Periotest was described by Schulte.[2] It measures the dampening effect against objects by a percussion rod that is electronically guided by a microcomputer. A force of 12-18 N is developed on a piston rod that impacts an implant, 04 times per second for 04 times (16 impacts). The more stable the implant, the quicker the percussion rod rebounds back in the handpiece. The microcomputer calculates the time that the rod is in contact with the implant and converts it into Periotest value readings. These values range from -8 to +50 numbers. Negative values indicate that the implant is stable and well osseointegrated. A study conducted by Truhlar *et al*[2] and Carl E. Misch[3] found that the Periotest instrument is capable of assessing implant stability.

In this study, at the end of six months after implant placement and before prosthetic loading, the average value of Periotest was -1.9, with a range from -8 to -1. These values denote significant implant stability and osseointegration.

The radiographic evaluation of crestal bone loss was done by digital OPG, with standardized parameters.

Table 1: Observations

S. No.	Implant size (in mm) [diameter/length]	Implant site	Periotest value	OPG mesial bone loss (in mm)	OPG distal bone loss (in mm)	Remarks
01	3.75/10	45	-2	0.3	0.2	
02	3.75/10	46	-	-	-	Failed
03	4/14	36	-2	0.6	0.5	
04	4/14	46	-3	0.6	0.5	
05	4/14	47	-1	0	0	
06	4/14	36	-3	0.8	0.6	
07	4/14	46	-2	0	0	
08	4/14	46	-1	0.3	0.5	
09	3.75/12	36	-3	0.5	0.5	
10	3.75/10	14	-4	0	0	
11	3.25/12	36	-1	1.0	1.2	
12	3.25/12	37	-1	0	0	
13	4/14	36	-1	0	0	
14	3.75/12	36	-1	0.5	0.5	
15	4/14	46	-2	0.5	0.5	
16	3.25/12	24	-1	0	0	
17	3.25/12	14	-1	0	0	
18	3.25/12	15	-1	1.0	1.0	
19	3.75/10	11	-	-	-	Failed
20	4/10	36	-4	0	0	
21	4.9/10	37	-1	1.0	0.8	
22	3.75/12	46	-2	0	0	
23	3.75/12	36	-1	1.0	1.2	
24	3.75/12	47	-1	0	0	
25	3.75/10	36	-3	0	0	
26	4/12	25	-1	1.0	0.9	
27	4/12	36	-1	1.0	1.0	
28	3.75/10	14	-1	1.0	1.0	
29	4./10	24	-1	1.0	1.0	
30	4/12	37	-2	0	0	
31	4/12	46	-4	1.0	1.0	
32	3.75/10	11	-1	0	0	
33	3.25/10	12	-1	1.0	1.0	
34	3.25/10	22	-2	1.0	1.0	
35	4/14	46	-1	1.0	1.0	
36	4/10	24	-1	0.3	0.5	
37	4/10	36	-1	1.0	0.8	
38	4/10	45	-2	1.0	1.2	
39	3.75/12	36	-4	0	0	
40	3.75/12	36	-1	1.0	0.8	
41	3.75/12	46	-2	0.3	0.4	
42	3.25/10	11	-1	1.0	0.9	
43	3.25/10	21	-4	0.9	1.0	
44	3.75/12	36	-2	0.8	1.0	
45	3.75/12	46	-2	0.3	0.3	
46	3.75/10	35	-	-	-	Failed
47	3.25/10	14	-	-	-	Failed
48	4.9/10	36	-1	1.0	1.0	
49	4/10	37	-4	0.3	0.3	
50	4/10	46	-1	1.0	0.9	
51	4/10	36	-1	1.0	1.0	
52	3.25/12	11	-1	0	0	
53	3.25/12	21	-1	0.3	0.3	
54	3.75/12	34	-2	1.0	1.0	
55	3.75/12	41	-	-	-	Failed
56	3.75/12	36	-4	1.0	1.0	
57	3.75/10	34	-1	1.0	1.0	
58	3.75/10	33	-1	0.3	0.3	
59	3.75/10	43	-1	1.0	1.0	
60	3.75/10	44	-1	1.0	1.0	
61	3.25/12	23	-2	0	0	
62	3.25/10	14	-4	1.0	1.0	
63	3.75/12	36	-8	1.0	1.0	
64	3.75/10	36	-4	0.3	0.2	
65	3.25/10	24	-4	1.0	1.2	

Table 1: Observations (Continued)

S. No.	Implant size (in mm) [diameter/length]	Implant site	Periotest value	OPG mesial bone loss (in mm)	OPG distal bone loss (in mm)	Remarks
66	3.75/12	36	-2	1.0	0.8	
67	3.25/12	35	-2	1.0	1.0	
68	3.25/12	31	-2	1.0	1.0	
69	3.25/12	41	-2	0	0	
70	3.75/12	33	-1	1.0	1.0	
71	3.75/12	43	-2	1.0	1.0	
72	3.75/10	36	-2	1.0	1.0	Failed
73	3.75/10	46	-	-	-	
74	3.75/10	16	-2	1.0	1.0	
75	3.75/10	25	-6	1.0	1.0	
76	3.75/10	26	-2	0.3	0.5	
77	3.75/12	46	-1	1.0	1.2	
78	3.75/10	14	-1	0	0	
79	4/10	47	-1	1.0	1.0	
80	3.75/12	46	-	-	-	Failed
81	3.75/8	26	-1	0.3	0.3	
82	3.75/8	46	-1	0	0	
83	3.75/10	36	-1	1.0	1.0	
84	3.75/10	36	-1	1.0	1.0	
85	3.25/12	34	-1	0.3	0.3	
86	4.9/10	36	-1	1.0	1.0	
87	4/10	36	-1	0	0	
88	3.25/10	26	-1	1.0	1.0	
89	3.75/12	45	-4	1.0	1.0	
90	3.75/12	46	-6	1.0	1.0	
91	3.25/10	21	-1	0	0	
92	3.75/12	36	-1	1.0	1.0	
93	3.75/10	36	-1	1.0	1.0	
94	3.25/12	21	-1	1.0	1.0	
95	3.75/12	21	-1	1.0	1.2	
96	3.75/10	33	-1	0.3	0.3	
97	3.75/10	32	-4	1.0	1.0	
98	3.75/10	42	-1	0	0	
99	3.75/10	43	-1	1.0	1.0	
100	3.25/12	21	-1	1.0	1.0	

Table 2: Mean values

Periotest value	OPG mesial bone loss (in mm)	OPG distal bone loss (in mm)
-1.9	0.6	0.9

The resorption of crestal bone around endosseous implants is an area of concern with all available implant systems. There is a lack of agreement on why there is crestal bone loss around the implant neck, that too more, during the first year of implant service. Various authors have suggested reasons for it. The implant crest module design of the neck influences the amount of crestal bone loss.[4-6]

The smooth polished machined collar of the implant is meant to reduce plaque accumulation and is not a load- bearing zone.[5] The cortical bone is stronger to compressive stresses and weaker to shear stresses. A smooth collar does not transfer compressive stresses, but results in shear stresses to the crestal bone, which results in lack of mechanical loading and stimulation.[7] This lack of stimulation results in bone loss. The implants used in this study (Pitt-Easy Bio-Oss, Oraltronics) had 2mm of smooth polished collar design. The junction of smooth collar and rough TPS coated threaded portion lies about 2 mm below the crest of bone at the time of implant placement, as the implants were placed at the level of crest. Thus, the smooth collar design may account for the initial crestal bone loss, even before loading the implant. Hammerle *et al*[8] had suggested that the smooth polished surface in contact with the bone results in crestal bone loss.

Hanggi MP *et al*[9] showed that crestal bone level remodelled down upto the junction of smooth and rough portion of implant. They also suggested that crestal bone remodeling was not dependent on implant loading, as it is a physiological change which starts as soon as the implant is placed in the bone. Hermann, Buser, Schenk and Cochran[10] showed that peri-implant crestal bone reaction is dependent on rough-smooth implant border. These studies indicate that greater the smooth polished collar length on the implant neck, greater will be the crestal bone loss.

This explains the crestal bone loss of 0.6 mm on the mesial side of the implant and 0.9 mm on the distal side observed in this study.

CONCLUSION

A study was undertaken to evaluate implant stability and crestal bone loss occuring six months after implant placement, before loading it. 100 two-stage implants were placed in 56 patients. After six months, the implant stability was evaluated by Periotest and the crestal bone loss on the mesial side and distal side of implant was evaluated by digital OPG. Mean Periotest value of -1.9 showed that the implants were well osseointegrated and stable. The mean crestal bone loss on the mesial side of the implant was 0.6 mm and on the distal side was 0.9 mm. The implants used in this study had smooth polished collar of 2 mm, which may have led to lack of compressive stress stimulation to the crestal bone, leading to the observed bone loss.

The results of this study are in concurrence with other quoted studies. Further extensive studies would substantiate the data. More stress should be given on developing implant collar design to reduce the initial crestal bone loss.

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