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Prevalence of peri-implant disease on platform switching implants: a cross-sectional pilot study

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Abstract: The objective of this study was to assess the prevalence of mucositis and peri-implantitis associated with the use of two types of implants—conventional versus platform switching after one year of loading. A longitudinal study of 64 implants in 25 patients was performed. Clinical variables, such as clinical pocket depth and bleeding upon probing, plaque, mobility, gingival recession, clinical attachment loss, and radiographic bone loss, were analyzed. The case definition for peri-implantitis was established as pockets of ≥ 5 mm with bleeding and bone loss ≥ 2 mm. One year after implant loading, the prevalence of mucositis and peri-implantitis with conventional implants (CIs) was 81.2% and 15.6%, respectively. For platform switching implants (PSIs) the prevalence was 90% and 6.6%, respectively. These differences were not statistically significant (p = 0.5375). However, there was a trend towards a lower prevalence of peri-implantitis with platform switching Implants.

Keywords: Dental Implants; Prevalence; Peri-Implantitis.

Introduction

Currently, the functional and aesthetic restoration of partially or totally edentulous areas with dental implants is widely accepted. Survival rates for dental implants evaluated in several systematic reviews and meta-analyses are > 90% and depend on the time of evaluation. Success rates are generally lower and are controversial owing to a lack of homogeneity in case definition criteria or lack of reporting.[1,2]

Modifications to conventional implant system (CIs) have been proposed in search of better restorative, aesthetic, and biological results. Platform switching implants system (PSIs) utilize an abutment with a smaller diameter aim to preserve the crestal bone level.[3,4] Most studies have compared the radiographic bone level between PSIs and CIs. Some studies have proposed that crestal bone stability is a consequence of the internal displacement of the abutment-implant junction, which displaces the inflammatory infiltrate away from the crestal bone and creates a space for the formation of biologic width.[3,4,5,6]

PSIs may preserve the marginal bone by decreasing the forces around the implant concentration of forces inward, resulting in the preservation of crestal bone level.[7] Some studies suggest that there are no significant differences in crestal bone level among different platform designs.[6,7,8,9]

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The success of dental implants is evidenced by their permanence over the active load period under ideal conditions, limiting crestal bone loss,pocket formation, marginal bleeding, and recession.[7,8] The Sixth European Workshop's consensus on periodontics reported a prevalence of mucositis in 50% of implants (80% of patients) and a prevalence of peri-implantitis in 12-40% of implants (28-56% of patients).[10] The controversy regarding the prevalence is due to many factors, such as the case definition used, the characteristics of the population evaluated, and the follow-up period. Numerous studies have shown the impact of PSIs on the preservation of crestal bone level,[11,12,13,14] but few studies have focused on the impact of the implant-abutment connection and the onset of mucositis and peri-implantitis.

The aim of this study was to test the hypothesis that PSIs are positively associated with better clinical parameters. We evaluated the prevalence of mucositis and peri-implantitis in two different types of implants (PSI *vs.* CI) after one year of loading. Additionally, differences in plaque index, clinical probing depth (PD), clinical attachment loss (CAL), gingival recession (REC), bleeding, suppuration, and crestal bone level were evaluated.

Methodology

A cross-sectional study was conducted to assess the prevalence of mucositis and peri-implantitis. Patients treated at *Universidad CES* (Medellin, Colombia) between 2011 and 2014 were evaluated if they met the inclusion criteria and agreed to participate in the study after signing the informed consent. Inclusion criteria included: periodontally healthy patients with at least one CI and one PSI placed in the same surgery at least one year ago. Exclusion criteria were: uncontrolled systemic disease, such as diabetes, osteoporosis, smoking, periodontitis or a personal history of radiotherapy. This study was approved by the regional ethics committee under Article 11 of Resolution 8430 of 1993 governing the terms for research on living beings in Colombia and the declaration of Helsinki. The Institutional Ethics Committee approval number was 230. The sample size of this study was 118 implants in 49 patients who had received both implant designs, 64 implants in 25 patients were followed clinically and radiographically for the pilot study (Figure).

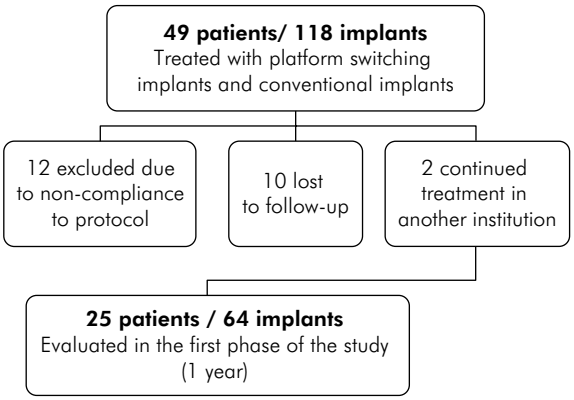

Figure. Flowchart.

Two different implant-abutment connections were studied. A PSIs was used in the test group (The Certain PREVAIL implant, BIOMET *3i*, Palm Beach Gardens, USA), and CIs was used for the control group (OSSEOTITE Certain implant, BIOMET *3i*, Palm Beach Gardens, USA). The implants were placed randomly by three operators previously trained in the surgical technique and employed in the dental clinic of *Universidad CES* in Medellin, Colombia.

Clinical evaluation

A trained examiner evaluated clinical parameters one year after implant loading. The inter-examiner concordance for quantitative variables showed an interclass correlation coefficient of 0.85 for clinical probing depth. Six sites per implant were evaluated with probe PCPUNC156 from Hu-friedy. The primary outcome variable was clinical probing depth (PD), and the secondary measures were bleeding upon probing, gingival recession (REC), clinical attachment loss (CAL), suppuration, mobility, plaque index, type of restoration (provisional or definitive), type of fixation (screwed or cemented), and prosthesis design (unitary or splinted implants).

Radiographic evaluation

Periapical images of each of the implants at the baseline and one year after implant loading were obtained. A customized parallel technique for the analysis of the crestal bone level was used. The effective radiation dose was 5 mSv per radiograph. The equipment used for scanning images was

Vistascann perio from the producer Dental Durr of Germany, and the software for measuring and analysis was DBSWIN. A radiology assistant previously standardized for evaluation of radiographic variables used a plastic Rinn block with an acrylic bite to record the incisal/occlusal position of the provisional or definitive implant crown. This was done to ensure a good radiographic orientation, and the image magnification was constant. The radiographic method used periapical images obtained on photostimulable phosphor plates, which allow a resolution of up to 40 LP/mm. The quality of the final image was evaluated following the radiology center's quality assurance protocol. An unbiased examiner evaluated all radiographs using standard operating procedures to ensure accuracy and precision. The examiner measured the coronal-apical level of the crestal bone and its relation to the proximal surfaces (mesial and distal) in each implant, obtaining the distance from the implant's shoulder to the first bone-implant contact, which was the starting point of the initial radiograph.[15,16] Radiographs were evaluated with the software DBSWIN to calculate the corresponding lengths based on changes in the crestal bone level. Patients diagnosed with peri-implantitis were referred to a periodontist for appropriate treatment.

Statistical analysis

Data analysis was carried out with SPSS statistical software version 21.0 (SPSS Inc., Chicago, USA). All quantitative variables (age, probing depth, radiographic bone loss, gingival recession, and clinical attachment loss) were summarized and presented as the mean ± standard deviation. The qualitative variables (gender, mobility, bleeding upon probing, suppuration, plaque, prosthetic design and fixation of restoration) were summarized and presented as absolute and relative frequencies, with the latter expressed in percentages. Qualitative variables (gender, mobility, bleeding upon probing, suppuration, plaque, prosthetic design and fixation of restoration) are presented as absolute and relative frequencies, with the latter expressed in percentages. Owing to the limitations of the study's sample size, an exploratory analysis was performed to compare the clinical and radiographic variables between the two types of implants using the Student's t-test for independent samples. Owing to the limitations of our sample size, we limited our study to an exploratory analysis that compared the clinical and radiographic variables between the two types of implants using the Student's t-test for independent samples. For all statistical tests, a p-value of < 0.05 was considered statistically significant. Finally, proportion indicators were used to determine the prevalence of mucositis and peri-implantitis for each type of implant.

Results

In this study, 64 implants were evaluated as the unit of analysis in 25 patients. Patient ages ranged from 33 to 84 (mean: 54 ± 12 years), and there was a predominance of females (72%).

Of the 64 implants, 33 (52%) were in the control group and 31 (49%) were in the test group. No implants showed mobility. There were no significant differences in the type of restoration, prosthetic design, mounting type, length, or diameter of the implants between the two systems (PSI and CI) at the time of evaluation (Table 1).

There were no significant differences between the implant systems in terms of bleeding upon probing, suppuration, plaque, or prevalence of pockets ≥ 4 mm with bleeding. The prevalence of pockets ≥ 5 mm was 24.2% for CIs and 12.9% for PSIs, and this difference was not statistically significant. Only one implant in the PSIs group had pockets ≥ 6 mm (Table 2).

The average depth upon clinical probing, clinical attachment loss, and recession were not statistically different between the two systems. The mean interproximal bone loss in the test group was 1.48 ± 0.81 mm, and in the control group it was 1.97 ± 0.90 mm, revealing a statistically significant difference between the two systems (Table 3).

The prevalence of mucositis was 72.7% for the control group and 83.8% for the test group, and the prevalence of peri-implantitis was 24.3% and 12.9%, respectively, using only a 5 mm pocket cutoff. The prevalence was similar for both systems. It did not matter if the implants were screwed or cemented. Whether the implants were screwed or cemented did not impact the results for the prevalence of mucositis. The appearance of mucositis was more prevalent in the unitary prosthetic design for both systems, but

Table 1. Conventional Implants (CI) and platform switching implants (PSI) characteristics in terms of length, diameter, design and type of prosthetic restoration.

Clinical Variables	CI	PSI	Total implants	p-value
	n (%)	n (%)	n (%)	X^2 Pearson
Type of implant	33 (51.6)	31 (48.4)	64 (100)	-
Type of Provisional Restoration	14 (53.8)	12 (46.2)	26 (40.6)	0.762
Type of Definitive Restoration	19 (50)	19 (50)	38 (59.4)	
Unitary implants	30 (50)	30 (50)	60 (93.7)	0.333
Splinted implants	3 (3.3)	1 (3.2)	4 (6.3)	
Cemented Implants	16 (53.3)	14 (46.7)	30 (46.9)	0.790
Screwed Implants	17 (50)	17 (50)	34 (53.1)	
Implants with 8.5 mm length	5 (50)	5 (50)	10 (15.6)	0.863
Implants with 10 mm length	10 (52.6)	9 (47.4)	19 (29.7)	
Implants with 11.5 mm length	8 (44.4)	10 (55.6)	18 (28.1)	
Implants with 13 mm length	10 (58.8)	7 (41.2)	17 (26.6)	
Implants with 4 mm diameter	24 (100)	-	24 (37.5)	-
Implants with 5 mm diameter	9 (100)	-	9 (14.1)	-
Implants with 4/3 mm diameter	-	20 (100)	20 (31.3)	-
Implants with 5/4 mm diameter	-	9 (100)	9 (14.1)	-
Implants with 6/5 mm diameter	-	2 (100)	2 (3.1)	

Table 2. Clinical parameters after 1 year of loading of conventional implants (CI) and platform switching implants (PSI).

	CI	PSI	Total surfaces	p-value
	n/N (%)	n/N (%)	n/N (%)	X^2 Pearson
Clinical Variables per area				
Bleeding on probing	152/198 (76.8%)	134/186 (72%)	286/384 (74.5%)	0.289
Suppuration	9/198 (4.5%)	13/186 (6.9%)	22/384 (5.7%)	0.303
Plaque	120/198 (60.6%)	99/186 (53.2%)	219/384 (57.0%)	0.144
Clinical Variables per implant				
Prevalence of implants that bled in at least one site	32/33 (97%)	30/31 (96.8%)	62/64 (96.9%)	0.9641
Prevalence of implants with pockets ≥ 4 mm with bleeding	14/33 (42.4%)	14/31 (45.2%)	28/64 (43.8%)	0.973
Prevalence of implants with pockets ≥ 5 mm with bleeding	8/33 (24.2%)	4/31 (12.9%)	12/64 (18.8%)	0.369
Prevalence of implants with pockets ≥ 6 mm with bleeding	0/33 (0%)	1/31 (3.2%)	1/64 (1.6%)	0.620

Table 3. Clinical and Radiographic results after 1 year of loading conventional implants (CI) and platform switching Implants (PSI).

Clinical and Radiographic Variables	CI	PSI	Total surfaces	p-value
	$\bar{X} \pm DE$	$\bar{X} \pm DE$	$\bar{X} \pm DE$	t-student
Clinical probing depth	2.7 ± 0.9	2.6 ± 1.2	2.7 ± 1.1	0.296
REC	0.3 ± 0,7	0.24 ± 0,6	0.3 ± 0,7	0.509
NIC	-2.5 ± 1,0	-2.4 ± 1,2	-2.4 ± 1,1	0.558
Bone loss (mm)	1.97 ± 0,90	1.48 ± 0,81	-1.73 ± 0,88	0.030

the difference was not statistically significant. The prevalence of mucositis tended to be greater for the unitary prosthetic design for both systems, but the difference was not statistically significant (Table 4).

Clinical and radiographic variables in the prevalence of mucositis and peri-implantitis

We carried out clinical and clinical-radiographic analyses to determine the prevalence of mucositis

and peri-implantitis. For the clinical-radiographic analysis of peri-implantitis, the case definition used was that of Persson *et al*.[17]

The radiographic analysis, unlike the clinical analysis, could only be performed on 62 implants given that one patient did not attend the radiology center for the final evaluation. There was no significant difference in the prevalence of peri-implantitis or mucositis between the two systems, but a trend was noted towards a lower prevalence of peri-implantitis in the PSIs group (Table 5).

Discussion

The Sixth European Workshop suggested two definitions for peri-implant diseases that should be adopted in future research: peri-implant mucositis, based on the clinical parameter of bleeding upon probing without loss of bone support, and peri-implantitis, defined as detectable bleeding upon probing and bone loss after one year of loading.[10] Currently there is controversy over the case definition of peri-implantitis. Different definitions have been reported in the literature. Leonhardt *et al*.[18] defined it as bone loss ≥ 3 threads, the presence of a pocket, and suppuration. Botero *et al*.[19] defined it as pockets ≥ 4 mm with bleeding upon probing.[18] Schwarz *et al*.[20] defined it as bone loss > 3 mm, pockets > 6 mm, and bleeding upon probing. Persson *et al*.[17] defined it as bone loss ≥ 2 mm, pockets ≥ 5 mm, and bleeding upon probing. Finally, Persson *et al*.[21] defined it as bone loss > 2.5 mm, pockets ≥ 4 mm, and bleeding or suppuration upon probing. The prevalence of peri-implantitis is difficult to determine because of different case definitions and follow-up periods. For example, one study reported a prevalence of 6.61% over a period of 9-14 years,[22] another found a prevalence of 23% during a 10 - year period,[23] and a third study reported a prevalence of 36.6% with an average follow-up period of 8.4 years.[24]

Different implant systems have been developed to preserve the crestal bone level, which improves the cosmetic results and reduces biological complications including peri-implant bone loss during the first year of function.[5] This pilot study is the first to evaluate the differences in clinical parameters between PSIs and CIs. Although some studies have claimed that the PSI system reduces bone loss,[3,4,5] there are no reports comparing the prevalence of peri-implant diseases

Table 4. Prevalence of mucositis and peri-implantitis using the clinical criteria of pockets ≥ 5 mm according to implant system (CI *vs*. PSI), fixation and prosthetic design.

		CI			PSI			p-value
		Healthy	Mucositis	Peri-implantitis	Healthy	Mucositis	Peri-implantitis	
		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)	
Fixed	Cemented	0 (0)	12 (75)	4 (25)	1(7.1)	12 (85.7)	1 (7.1)	0.262
	Screwed	1 (5.9)	12 (70.6)	4 (23.5)	0 (0)	14 (82.4)	3 (17.6)	0.523
	p-value	0,921						
Prosthetic Design	Unitary	1 (3.3)	22 (73.3)	7 (23.3)	1 (3.3)	25 (83.3)	4 (13.3)	0.604
	Splinted	0 (0)	2(66.7)	1 (33.3)	0 (0)	1 (100)	0 (0)	0.505
	p-value				0.892			

Table 5. Prevalence of mucositis and peri-implantitis according to clinical and radiographic parameters with a 5 mm cutoff and bone loss ≥ 2 mm.

Diagnosis	CI	PSI	Total Implants
	n/N (%)	n/N (%)	n/N (%)
Healthy (no bleeding with any pocket or sulcus without bone loss)	1/32 (3.0%)	1/30 (3.2%)	2/62 (3.2%)
Mucositis (sulcus with bleeding on probing with radiographic bone loss < 2 mm)	26/32 (81.25%)	27/30 (90%)	53/62 (85.5%)
Peri-implantitis (sulcus ≥ 5mm with bleeding on probing and radiographic bone loss ≥ 2mm)	5/32 (15.6%)	2/30 (6.6%)	7/62 (11.3%)

p-value: 0.5375.

(mucositis and peri-implantitis) between PSIs and CIs. Our present study used the definition of Persson in 2006 and found a prevalence of peri-implantitis of 15.6% with CIs and 6.6% with PSIs. Although the difference was not statistically significant, a trend towards a lower prevalence of peri-implantitis in the test group was observed. Of 118 implants in 49 patients treated with both implant designs, 64 implants in 25 patients were monitored clinically and radiographically. One limitation of this pilot study was the high rate of withdrawals and dropouts. In total, 12 patients did not comply with the protocol and were excluded from the analysis (withdrawals). The main reason was the lack of compliance with the implant loading protocol (6 months) established in the study. An additional 12 patients left the study (dropouts) during the monitoring stage. These findings should be evaluated in further studies with larger samples and longer follow-up periods. The prevalence of peri-implant mucositis was 81.3% for CIs and 90.0% for the PSI system.

In the present study, no statistically significant differences were found between the two implant systems with regard to clinical variables, such as bleeding upon probing, depth upon clinical probing, suppuration, plaque index, and mobility. These results are consistent with those of a controlled randomized clinical trial in which no differences in clinical parameters between CIs and PSIs were found.[25] A histological study concluded that both systems had the same histological and soft-tissue characteristics despite changes in bone levels.[26]

In this preliminary report, statistically significant differences in mean radiographic bone loss between the two groups of implants were observed. Several clinical and histological studies have reported that the PSI system results in less crestal bone resorption.[6,25] A controlled clinical trial reported 30% less crestal bone loss in implants that had abutments with smaller diameters. After a year of loading, average bone loss was 0.94 mm for the CI system and 0.66 mm for the PSI system.[27] Studies in animals and humans found no difference in crestal bone remodeling in immediate implant abutments with different configurations.[15,28]

Failure to comply with follow-up visits may explain the high percentage of plaque in this study (57%), in which 96.9% of the implants had at least one bleeding site. The presence of plaque and bleeding upon probing are associated with an increased risk of peri-implant diseases.[29,30] Experimental studies on peri-implantitis have shown that increased probing depth (PD) is related to bone loss and clinical attachment loss (CAL).[29,30]

The prevalence of peri-implantitis in this study was 6.6% with PSIs and 15.6% with CIs. Although no differences in the prevalence of peri-implant diseases were found, there was one patient who had a ≥ 6mm pocket, in whom radiographically excess cement was found. The retention of cement in the peri-implant sulcus and the restorative margin can sometimes explain the occurrence of these diseases.

In this pilot study, systemically healthy patients, with no history of periodontitis or smoking, were evaluated. The patients had lost their teeth for reasons not associated with periodontitis, such as caries, fractures, or endodontic complications. An increased risk of peri-implantitis occurs in smokers compared with nonsmokers (reported odds ratios from 3.6 to 4.6). The combination of a history of treated periodontitis and smoking increases the risk of implant failure and peri-implant bone loss.[31] Further studies in different populations with longer follow-up periods should be performed, and the behavior of tissues with different implant designs and other risk factors should be evaluated.

Conclusions

The prevalence of peri-implant mucositis was 81.2% for CIs and 90% for the PSIs. There was a trend towards a lower prevalence of peri-implantitis (not statistically significant) with PSI (6.6%) compared with CI (15.6%).

The mean interproximal bone loss in the test group was 1.48 ± 0.81 mm, whereas in the control group it was 1.97 ± 0.90 mm, revealing a statistically significant difference between the two systems. There were no statistical differences in clinical parameters.

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