

Possible Association between the Quantity of Peri-implant Crevicular Fluid, Clinical Indices, and the Dimensions of Endosseous Implants

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ABSTRACT

Objectives: The objectives of this clinical observational study are to measure peri-implant crevicular fluid volume based on dental implant diameter and length, and to evaluate the possible relationship between peri-implant crevicular fluid/gingival crevicular fluid volumes and clinical periodontal indices.

Material and Methods: The information about length and diameter of dental implants was noted. Clinical indices (probing depth, plaque index, gingival bleeding time index, and gingival index) were recorded. Peri-implant crevicular fluid (PICF)/gingival crevicular fluid (GCF) volumes were measured from 4 sites (mesial, buccal, distal, and lingual/palatal) of each dental implant including its one or more equivalent natural tooth/teeth.

Results: One-hundred-sixty-one loaded dental implants and 221 natural teeth of 101 patients were evaluated. The length of dental implant had no effect on PICF volume ($P > 0.05$). However, PICF volumes of narrow (< 3.5 mm) and wide (> 4.5 mm) diameter implants were higher than standard diameter implants (≥ 3.5 mm, and ≤ 4.5 mm) ($P < 0.05$). PICF and GCF volumes of areas with peri-implant/periodontal diseases were significantly higher than healthy areas ($P < 0.05$). PICF and GCF volumes showed positive correlations with clinical indices ($P < 0.05$).

Conclusions: In accordance with the results of the present study, the implant diameter, not the implant length, affects peri-implant crevicular fluid volume.

Keywords: dental implants; diagnosis; gingival crevicular fluid; inflammation.

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INTRODUCTION

Dental implant procedures are predictable treatment options for partially and/or totally edentulous patients to provide aesthetics and function. Recently, peri-implant diseases become to be more popular research topics in implant dentistry because of increasing prevalence of peri-implant diseases [1,2]. Peri-implant mucositis and peri-implantitis were first described at the 1st European Workshop on Periodontology in 1993 [3]. Bleeding on probing (BoP), and/or suppuration without any radiological bone loss defined as peri-implant mucositis. Peri-implantitis is characterized by loss of supporting bone around dental implant with deep pocket formation and BoP [4,5].

While evaluating peri-implant tissues, clinical and radiological parameters (probing depth, BoP, suppuration, marginal bone loss, implant mobility, etc.) should be considered together [6]. Some limitations of clinical diagnosis require to find more specific and sensitive diagnostic techniques for peri-implant diseases [7]. Assessments of biomarkers (interleukins, matrix metalloproteinases, enzymes, etc.) in secretions such as saliva, gingival crevicular fluid (GCF), and peri-implant crevicular fluid (PICF), provide more tools for accurate diagnosis [8]. However, this technique is not used for daily practice because of long-time laboratory process and its cost [7].

GCF is an interstitial fluid in clinically healthy sites. In the presence of the periodontal inflammation, ingredients of GCF change. GCF becomes inflammatory exudate which is secreted by inflamed gingiva [9]. Besides, increasing of PICF/GCF volumes are noted in direct proportions to the increased inflammation in the literature [10,11]. Hence, the objectives of this clinical observational study are to measure PICF volume based on implant length and diameter, and further evaluate the possible relationships between PICF/GCF volumes and clinical indices.

MATERIAL AND METHODS

Study design

This clinical observational study was approved by the Ethics Boards and Commissions at Hacettepe University (GO 15/328-19) in accordance with Helsinki Declaration 1975, as revised in 2000.

The inclusion criteria were: 1) the patients older than 18 years; and 2) the patients whose dental implants were functionally loaded more than 12 months. The

included subjects were not evaluated based on jaw (maxilla/mandible) or region (anterior/posterior).

The exclusion criteria were as follows: 1) smokers; 2) having systemic diseases/status (diabetes mellitus, pregnancy, etc.) that may affect periodontal and peri-implant tissues; 3) having periodontal treatment in last 6 months; and 4) using medicine (corticosteroid, antibiotics, mouthwash, etc.) that may affect PICF/GCF volumes. Informed consent forms were obtained from each participant and necessary periodontal treatments were scheduled after sampling.

Collecting data

One-hundred-sixty-one loaded implants and 221 natural teeth of 101 patients were evaluated (by O.D. and N.Y.) at Hacettepe University Faculty of Dentistry, Department of Periodontology between June 1, 2015 and June 1, 2017. The information about the length and the diameter of dental implants were taken from the patients' dental records. Once supragingival plaque was removed and the sampling areas were isolated with cotton rolls, PICF/GCF samples were collected from 4 sites (mesial, buccal, distal, and lingual/palatal) of each dental implant and its one or more equivalent natural tooth/teeth on opposite sides of the mouth. Standard paper strips (Periopaper® - OraFlow Inc.; Amityville, New York, USA) were inserted into 1 mm depth of sulcus for 30 seconds [12]. Strips contaminated with blood were discarded and mechanical irritation was avoided. GCF and PICF volumes were measured with a Periotron (Periotron 8000 - OraFlow Inc.; Amityville, New York, USA). Clinical indices including, probing depth (PD), plaque index (PI) [13], gingival bleeding time index (GBTI) [14], and gingival index (GI) [15] were recorded from 4 sites (mesial, buccal, distal, and lingual/palatal) of the same tooth/dental implant by using a periodontal probe (Williams Periodontal Probe, Hu-Friedy, Chicago, IL, USA). Dental implants/teeth with GI values equal and more than 1 were classified as areas with peri-implant/periodontal disease. Contrary, peri-implant/periodontal areas those showed GI values less than 1 are considered as healthy.

Statistical analysis

Based on percentage measurements related to the methods to be studied, with the effect size of 0.3, 90% power, and 0.5 error margin, total sample size was calculated 382. All statistical data were processed using software IBM SPSS Statistics for Windows Version 24.0 (IBM Corp.; Armonk, NY, USA).

Table 1. GCF and PICF volumes according to peri-implant/periodontal status

Parameter	Periodontal/peri-implant health		Periodontal/peri-implant disease		P-value
	Periodontal	Peri-implant	Gingivitis	Peri-implant mucositis	
PICF (µl)	-	0.36 (0.41)	-	0.44 (0.39)	0.032 ^a
GCF (µl)	0.32 (0.22)	-	0.42 (0.25)	-	0.008 ^a

^aStatistically significant at level P < 0.05 (Mann-Whitney U tests).
GCF = gingival crevicular fluid, PICF = peri-implant crevicular fluid.

Assumption of normality for the data were tested using Kolmogorov-Smirnov normality test. Kruskal-Wallis and Mann-Whitney U tests were applied since parametric test assumptions were not satisfied. The relationship between PICF and GCF values with respect to other clinical parameters were analyzed by calculating Spearman rank-order correlation coefficient. While comparing dental implant length and diameter subgroups, Chi-square test was performed. Parametric data were expressed as mean and standard deviation (M [SD]). Statistical significance level was defined at P = 0.05.

RESULTS

The present study included 161 loaded implants and 221 natural teeth of 101 patients. The mean age of the participants was 48.56 (9.88) (ranged between 27 and 77 years). PICF volumes were significantly higher at sites with peri-implant diseases (0.44 [0.39] µl) compared to clinically healthy sites (0.36 [0.41] µl) (P = 0.032). This finding was identical in volumes of the GCF subgroups (P = 0.008). The differences of PICF and GCF volumes between subjects with peri-implant/periodontal diseases and healthy sites were significant (P < 0.05) (Table 1). Mean values for clinical indices of natural teeth and dental implants were presented in Table 2. Moreover, PICF and GCF volumes showed positive correlations with all clinical indices (PD, PI, GI, and GBTI) (P < 0.05).

In Table 3, no significant difference was found

Table 2. Average values of clinical indices for natural teeth/dental implants

Clinical indices	Tooth	Dental implant
	Mean (SD)	Mean (SD)
Gingival index	0.88 (0.67)	0.82 (0.71)
Plaque index	0.75 (0.61)	0.43 (0.05)
Probing depth	2.46 (1.54)	2.62 (1.32)
Gingival bleeding time index	0.71 (0.7)	0.88 (0.09)

SD = standard deviation.

between the subgroups based on dental implant length (P = 0.359). Wide (> 4.5 mm) diameter implants had the highest PICF volume values (0.68 [0.31] µl). Narrow implants (< 3.5 mm) demonstrated a statistically significant difference in PICF volumes (0.48 [0.22] µl) compared with standard diameter implants (≥ 3.5 mm and ≤ 4.5 mm) (0.36 [0.19] µl) (P = 0.027) (Table 3).

DISCUSSION

Dental implant is the most popular treatment option for edentulous patients in last decades. Therefore, diagnosis and treatment of peri-implant diseases become more important with increasing number of peri-implant diseases [1,2]. To diagnose peri-implant diseases, clinical periodontal indices (PD, PI, GBTI, and GI), and PICF levels of biomarkers and/or enzymes (interleukins, cathepsin-K, matrix metalloproteinase, myeloperoxidase, osteocalcin, etc.) are used [12,16-20]. In addition to assessment of the biomarker levels in PICF, volume of PICF is measured for detecting inflammation of peri-implant tissues in some studies [21,22].

Increasing volume of GCF is related to the severity and the extension of gingival inflammation [11,12,19].

Table 3. The peri-implant crevicular fluid (PICF) changes according to the implants with different length and diameters

Parameter	PICF volume (µl)	P-value
	Mean (SD)	
Implant length		
< 8 mm	0.36 (0.17)	0.359
≥ 8 mm	0.39 (0.21)	
Implant diameter		
Narrow (< 3.5 mm)	0.48 (0.22)	0.027 ^a
Standard (≥ 3.5 mm and ≤ 4.5 mm)	0.36 (0.19)	
Wide (> 4.5 mm)	0.68 (0.31)	

^aStatistically significant at level P < 0.05 (Chi-square test).
SD = standard deviation.

Some studies reported that the relationship between PICF and peri-implant inflammation was like the association between GCF and periodontal disease [12,23-25]. Parallel to the literature, PICF/GCF volumes of the patients with peri-implant/periodontal diseases were higher than healthy subjects in the present study ($P < 0.05$). Moreover, all clinical indices (PD, PI, GI, and GBTI) showed positive correlations with volume changes of both fluids which are in line with the literature [12,23,25-28]. This information may prove us that PICF is a diagnostic analog of GCF for peri-implant diseases.

Gunday et al. [23] presented that increased PICF volumes were associated with increasing length of dental implants. Contrary, the length of dental implant had no effect on PICF volume, regardless of the inflammation in the present study ($P > 0.05$). Gunday et al. [23] categorized dental implant length as: 1) long (≥ 12 mm); 2) medium ($12 < \text{and} > 9$ mm); and 3) short (≤ 9 mm). However, the authors subgrouped as short (< 8 mm) and long (≥ 8 mm) in the present study. Various dental implant length subgroups may vary the results of the studies. In the literature, it was denoted that PICF volumes of wide (> 3.8 mm) (0.165 [0.161] μl) diameter implants were higher than narrows (≤ 3.8 mm) (0.141 [0.103] μl) [23]. In the present study, PICF volumes of narrow (< 3.5 mm) (0.48 [0.22] μl) and wide (> 4.5 mm) (0.68 [0.31] μl) diameter implants were measured significantly higher than standard diameter implants (≥ 3.5 mm, and ≤ 4.5 mm) (0.36 [0.19] μl) ($P < 0.05$). According to PICF volume presents results, one may speculate that preferring standard diameter implants (≥ 3.5 mm, and ≤ 4.5 mm) may present less risk of peri-implant diseases than narrow (< 3.5 mm) and wide (> 4.5 mm) diameter implants. Although wide diameter implants with wider peri-implant sulcular area showed higher PICF volume values, absence of definite distinction for implant diameter and limited sample size were interrupted results of the study. Different groups of dental implant diameters may cause the contraries. In addition, further studies with homogenic subgroups based on diameter and length of dental implants should be planned.

Various biomarkers were used to investigate for the diagnosis of peri-implant and periodontal diseases. However, evaluating PICF levels of biomarkers are not used for daily practice because of their limitations [7]. Moreover, lack of publication about dental implant related factors affecting on PICF was published in the literature. In this clinical study, the authors evaluated the relationship between PICF volume and clinical indices. Besides, dental implant related factors may affect PICF volume were detected. As a limitation, dental implants were not be categorized according to implant - abutment connection type and dental implant location (anterior/posterior and/or maxilla/mandible). Additionally, the patients included the present study were not evaluated according to age and gender. Within the limitations of the study, the length of dental implant had no effect on PICF volume. However, narrow (< 3.5 mm) and wide (> 4.5 mm) diameter implants showed higher PICF volume values than standard diameter implants (≥ 3.5 mm, and ≤ 4.5 mm). In addition, PICF volume was increased while presenting peri-implant diseases like the association between GCF and periodontal disease. Further studies with more samples are needed to confirm these results.

CONCLUSIONS

Peri-implant crevicular fluid and gingival crevicular fluid may both have potential for diagnosis of peri-implant/periodontal diseases. In accordance with the results of the present study, the implant diameter, not the implant length, affects peri-implant crevicular fluid volume.

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The authors report no conflict of interest related to this study.

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