Examining peri-implant and periodontal conditions co-occur: a cross-sectional study (#105496)

First submission

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Examining peri-implant and periodontal conditions co-occur: a cross-sectional study

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Introduction: Both peri-implant and periodontal conditions have underlying main factors, risk factors, microbiology, immunology, and treatments. **Aims:** This study aims to investigate the potential co-occurrence of peri-implant and periodontal conditions **Design:** One hundred twenty-three implants were divided into three groups: peri-implantitis (41 implants), peri-implant mucositis (41 implants), and peri-implant health (41 implants). Peri-implant and periodontal statuses were assessed using the 2017 AAP / EFP World Workshop on Classification of Periodontal and Peri-implant Diseases and Conditions. One-way Analysis of Variance was used to compare the study groups according to the data. An assessment was conducted regarding the coexistence of periodontal and peri-implant conditions. **Results:** While patients with peri-implant mucositis mostly had gingivitis and patients with peri-implant health had periodontal health, those with peri-implantitis mostly had gingivitis and relatively less periodontitis. A significant difference was observed between the peri-implant and periodontal groups (p=0.003). Significant differences were observed between peri-implant and periodontal evaluations for plaque indices, gingival indices, probing depth, gingival recession, and clinical attachment level (p=0.001), (p=0.006). **Conclusions:** The findings of this study underscore the intricate influence of implant treatment on periodontal health. This observation emphasizes the importance of elucidating underlying factors to improve clinical management and outcomes in patients with periodontal and peri-implant diseases, highlighting this research's relevance and potential impact in the field.

Examining Peri-İmplant and Periodontal Conditions Co-occur: A Cross-Sectional Study

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Abstract

"Peri-implant and periodontal conditions share common underlying factors including risk factors, microbiology, immunology, and treatment approaches."

Awkward phrasing. Consider like this:

Introduction: Both peri-implant and periodontal conditions have underlying main factors, risk factors, microbiology, immunology, and treatments. ?

Aims: This study aims to investigate the potential co-occurrence of peri-implant and periodontal conditions.

Inconsistent number formatting

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Run-on sentence: consider breaking this into two sentences for clarity.

Results: While patients with peri-implant mucositis mostly had gingivitis and patients with peri-implant health had periodontal health, those with peri-implantitis mostly had gingivitis and relatively less periodontitis. A significant difference was observed between the peri-implant and periodontal groups (p=0.003). Significant differences were observed between peri-implant and periodontal evaluations for plaque indices, gingival indices, probing depth, gingival recession, and clinical attachment level (p=0.001), (p=0.006).

Conclusions: The findings of this study underscore the intricate influence of implant treatment on periodontal health. This observation emphasizes the importance of elucidating underlying factors to improve clinical management and outcomes in patients with periodontal and peri-implant diseases, highlighting this research's relevance and potential impact in the field.

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Keywords: Periodontal disease; peri-implant health; peri-implant mucositis; peri-implantitis

Introduction

Establishing and maintaining oral health involves monitoring both peri-implant and periodontal conditions. Periodontal health and peri-implant health are defined by the absence of bleeding, swelling, or suppuration on probing, coupled with the absence of clinically evident inflammation. In peri-implant mucositis, akin to gingivitis in natural dentition, the initiation of inflammation occurs with microbial plaque accumulation; however, there is no extension of increased probing depth to the alveolar bone (*Berglundh et al., 2018*), (*Chapple et al., 2018*). Peri-implant mucositis is distinguished from peri-implantitis by triggering a localized inflammatory response and ultimately leading to the loss of supporting bone around the implant *(Berglundh et al., 2018)*, *(Renvert et al., 2018)*, *(Lee & Wang, 2010)*. Likewise, periodontitis, an enduring inflammatory condition, is typified by dysbiotic plaque biofilms and an immune - - dysregulation that promotes the destruction of the periodontal ligament and alveolar bone *(Sedghi, Bacino & Kapila, 2021), (Papapanou et al., 2018)*.

Periodontitis and peri-implantitis are inflammatory conditions caused by biofilms that can result in tooth and oral implant loss if not addressed *(Lasserre, Brecx, Toma, 2018)*. Compared with healthy areas in the same individual, inflamed regions (peri-implantitis and periodontitis) harbor unique dysbiotic subgingival microbial ecosystems *(Barbagallo et al., 2022)*. Periodontitis and peri-implantitis have been reported to be associated with a notable increase in microbial stability within the subgingival microbiome *(Zhang et al., 2021)*. Studies investigating peri-implant biofilms have predominantly focused on recognized periodontal pathogens like *Porphyromonas gingivalis* (*P. gingivalis*) and *Treponema denticola*. Furthermore, these results have highlighted similarities between the subgingival microbiota of periodontitis and peri-implantitis *(Kotsakis & Olmedo, 2021)*. In contrast, certain studies refute the notion of microbiota similarity between peri-implantitis and periodontitis *(Koyanagi et al., 2013), (Maruyama et al., 2014)*. In a broad sense, risk factors encompass patient-related, environmental, or practitioner-related elements. Patient-related risk factors encompass socio-economic status, smoking habits, substance abuse disorders, diabetes, dietary habits and supplementation, mental health conditions, advanced age, inadequate home dental care, limited understanding of the importance of proper oral hygiene, genetic polymorphisms, and medication usage *(Darby, 2022), (Kinane & Hart, 2003), (Vaz et al., 2012)*. Moreover, according to the report of the 6th Conference European Association for Osseointegration, prosthesis over-contouring and implant surface characteristics increase the risk of peri-implantitis *(Schwarz et al., 2021)*.

Individuals with a history of periodontitis are more susceptible to peri-implant infections and complications *(Renvert & Persson, 2009)*, *(Ferreira et al., 2018)*. A history of periodontitis can be assessed by evaluating periodontal bone loss on radiographs, examining dental records, or talking to the patient to determine the cause of tooth loss. The patient can also tell the cause of tooth loss. It is reasonable to include the stage and extent of periodontal disease in this assessment as it influences the development and progression of peri-implant disease *(Heitz-Mayfield, Heitz & Lang, 2020)*.

The peri-implant sulcus is histologically and immunologically distinct from the subgingival sulcus *(Robitaille et al., 2016)*. Increasing evidence has been obtained on the

development and causes of periodontal and peri-implant disorders. Although there are some similarities in the host's reactions in both settings, their differences can be attributed to the distinct composition of tooth-periodontium and implant-alveolar bone biointerfaces *(Larsson et al., 2022)*. The host response, pivotal in delineating the genetic basis of diseases like periodontitis and peri-implantitis, necessitates an examination of cytokines, chemokines, growth factors, and their receptors, crucial in understanding the pathogenesis of periodontal and peri-implant diseases *(Turkmen & Firatli, 2022), (Genco, 1992)*.

Periodontal and peri-implant diseases are mainly managed using manual instrumentation to reduce the bacterial load and improve the patient's at-home cleanliness *(Meffert, 1996)*. If required, further antibiotic therapies and laser treatments may be employed *(Mombelli, Lang, 1992), (Hammami & Nasri, 2021), (Diwan et al., 2024), (Ashnagar et al., 2024)*. Regenerative treatment can also be applied *(Larsson et al., 2016)*. Periodontitis and peri-implantitis reportedly have similar etiology and similar therapeutic interventions are performed in patients with the two entities *(Robitaille et al., 2016)*.

Since there are some commonalities in primary factors, risk factors, microbiology, immunology, and treatment interventions, it is hypothesized that periodontitis may co-occur in the presence of peri-implantitis, gingivitis may manifest in the presence of peri-implant mucositis, and periodontal health may be observed in the presence of peri-implant health. This study hypothesizes that there is a significant association between the presence of periodontitis and peri-implantitis, gingivitis and peri-implant mucositis, and periodontal health and peri-implant health.Therefore, this study aims to investigate the potential presence of periodontitis in patients with peri-implantitis, gingivitis in those with peri-implant mucositis, and periodontal health in those with peri-implant health.

Materials & Methods

This study complied with the World Medical Association Declaration of Helsinki for medical research *(Emanuel, 2013)*.

Patients who were previously examined for periodontal/peri-implant status, except excluded ones, at Bolu Abant İzzet Baysal University between July 2022 and November 2023, were included in the study. This clinical study was registered at ClinicalTrials.gov (NCT06128850/23.07.2024). → The registration shows March 31, 2023.

Awkward phrasing.

Ethical considerations

Bolu Abant İzzet Baysal University Clinical Researches Ethics Committee approved the study (2022/163-28/06/2022). The participants were informed about the procedures and signed the informed consent form.

Sample size calculation

It was planned to have three groups according to peri-implant health status in the study, and the sample size was calculated according to the study of Barwacz et al. *(Barwacz, 2018)* (2018). According to the results of power calculation using F test, fixed effects, special effects, main effects, and interaction analysis (G*Power 3.1 software; Heinrich Heine University,

Dusseldorf, Germany), with α (margin of error) = 0.05, power (1-β) = 0.90 and effect size (f)= 0.4, the required sample size for the three groups was 117, and the required sample size for each subgroup was at least 39. The effect size value was determined regarding the proposed large effect size convention.

Study design and participants

The study included 123 implants with fixed prostheses that had survived for at least six months following functional prosthetic loading, with the exception of patients with uncontrolled medical issues and referred clinical bruxism. Implants are 2–5 years old. The implant's fixed prosthesis is 1.5–4.5 years old. Two hundred twenty-four patients were evaluated, and 123 implants that fulfilled the inclusion criteria were included in the study. The plaque index *(Silness & Löe, 1964)*, gingival index *(Loe & Silness, 1963)*, probing depth, bleeding on probing *(Ainamo & Bay, 1975)*, clinical attachment loss (CAL), and gingival recession were recorded for the teeth and implants of patients from the mesiobuccal, distobuccal, mid-buccal, mesiopalatinal/lingual, mid-palatinal/lingual, and distolingual/palatinal regions. All indices were taken during the examination. The peri-implant and periodontal health statuses of the patients were examined. Healthy gingiva, displaying an intact periodontium, exhibits minimal bleeding on probing (<10%) and shallow periodontal pocket depths (≤3 mm). In contrast, gingivitis is characterized by increased bleeding on probing (≥10%) with pocket depths remaining ≤3 mm. Descriptions of periodontitis should encompass metrics such as the prevalence of bleeding on probing, the proportion of teeth with probing depths surpassing specified thresholds (commonly ≥4 mm and ≥6 mm), and teeth exhibiting clinical attachment loss (CAL) of ≥3 mm and ≥5 mm *(Papapanou et al., 2018)*. Peri-implant health was characterized by the absence of erythema, bleeding on probing, swelling, and suppuration. The main clinical characteristic of peri-implant mucositis is bleeding on gentle probing. Erythema, swelling, and/or suppuration may also occur. As outlined in the 2017 World Workshop on Periodontology guidelines, in cases where prior examination data is unavailable, diagnosing peri-implantitis may rely on concurrent indications such as bleeding or suppuration during gentle probing, probing depths measuring 6 mm or greater, and bone resorption levels reaching 3 mm or beyond apically from the most coronal aspect of the intra-osseous section of the implant *(Berglundh et al., 2018)*. The implants were divided into three groups: peri-implantitis, peri-implant mucositis, and peri-implant health. Each group was evaluated according to periodontal status (periodontal health, gingivitis, and periodontitis). A single clinician (T.Ş.) recorded all measurements in a single session.

An assessment was conducted regarding the coexistence of periodontal and peri-implant conditions.

Inclusion and exclusion criteria

This study included systemically healthy patients aged 18-70 who had undergone at least six months and at most five years of functional prosthetic loading of one or more dental implants with a fixed prosthesis.

Pregnant or lactating women, patients with a history of chronic use of anti-inflammatory agents, and those on immunosuppressive drugs or drugs that impact the mucosa and bones were

not included in the study. Patients who underwent treatment of peri-implant disease after implant placement, those with residual cement residue and prosthesis design, and those with malpositioned implants were also excluded from the study. Patients undergoing active periodontal treatment or treatment after implantation, diabetic patients, patients with mucosal diseases, and smokers were excluded.

Statistical analyses

Research analysis was conducted using the SPSS 26 (SPSS Inc., Chicago, IL, USA) statistical program. Shapiro Wilk normality tests were performed to determine whether the data met parametric test criteria. The study compared the three groups according to peri-implant health status. Paired sample t-tests were utilized to assess each group's implant and periodontal indices. The chi-square test was used to analyze categorical data. The level of significance was set at $p<0.05$. A total of 123 implants were analyzed, with 41 implants in each group based on peri-implant health status.

Results

1.1. Demographic characteristic

The demographic characteristics of the study population are presented in Table 1.

1.2. Distribution of groups

Implants were most commonly placed in relation to #16 (12.2%), #36 (11.4%), and #46 (8.9%). The peri-implantitis, peri-implant mucositis, and peri-implant health groups comprised an equal number of patients in (Table 2).

Comparison of groups

Individuals with peri-implantitis had higher rates of gingivitis and periodontitis, respectively. Periodontal health was primarily detected in patients diagnosed with peri-implant health and gingivitis was primarily detected in those with peri-implant mucositis. The most significant number of people diagnosed with peri-implant mucositis had gingivitis and periodontal health. A significant difference was observed between the peri-implant and the periodontal groups (p=0.003) (Table 3).

Unclear

Lack of specificity: What kind of difference? In what measure?

Comparison of indices

When peri-implant health and conditions were analyzed concurrently for plaque indices a significant difference was observed between the peri-implant and periodontal evaluations (p=0.001), (II=0.05-0.13, PI=0.19-0.30). The plaque index during periodontal evaluation was found to be greater than that during implant evaluation (Table 4).

A significant difference was observed in the context of gingival indices between peri-implant and periodontal evaluations in patients with peri-implantitis and peri-implant mucositis (p=0.001), (II=0.07-0.76, PI=0.07-0.14). The gingival index during implant evaluation was found to be greater than that during periodontal evaluation (Table 4).

In patients diagnosed with peri-implantitis, a statistically significant variance in probing depth was observed between assessments of peri-implant and periodontal regions (p=0.001), (II=3.24-4.59, PI=2,09-2,25). The probing depth during implant evaluation was found to be greater than that during periodontal assesment. Regarding the probing depth, there was not any significant difference between implant and periodontal assessments in patients with peri-implant mucositis and peri-implant health (p=0.165), (p=0.837), (II=2.00-2.28, PI= 1.70-2.26), (II=1.82-2.12, PI=1.98-2.14) (Table 4).

In the context of gingival recession, a significant difference was observed between peri-implant and periodontal recession in patients with peri-implantitis and peri-implant mucositis (p=0.001), (p=0.014), (II=0.27-1.17, PI=0.06-0.31), (II=0.04-0.46, PI=0.05-0.18). Periodontal evaluation revealed that gingival recession in implants was greater than that in teeth. Furthermore, no notable distinction was found regarding gingival recession between assessments of implants and periodontal health in patients diagnosed with peri-implant health (p>0.05), (p=0.410), (II=0.02-0.29, PI=0.08-0.38) (Table 4).

A significant difference was observed in terms of CAL between peri-implant and periodontal evaluations in patients with peri-implantitis (p=0.001), (II=3.28-4.67, PI=2.16-2.39). The CAL at the time of implant evaluation was more significant than that at the periodontal evaluation. There was no notable contrast in attachment loss values identified between assessments of implants and periodontal conditions in patients diagnosed with either peri-implant mucositis or peri-implant health (p=0.869), (p=0.971), (II=1.92-2.26, PI= 1.66-2.30), (II=1.79-2.17, PI=1.80-2.23) (Table 4).

As per the assessment of implants, a notable distinction in gingival recession was observed among the peri-implant groups (p=0.016). The peri-implantitis group exhibited the highest level of recession, which differed significantly from the other two groups, whereas the lowest gingival recession value was observed in the peri-implant health group.

Implant evaluation revealed a significant difference in gingival recession between the periodontal groups (p=0.020). The periodontitis group had the highest gingival recession rate, which differed significantly from the other two groups, whereas the periodontal health group had the lowest.

Discussion

This study tested whether peri-implant and periodontal conditions occurred simultaneously. It found that gingivitis was mainly detected in patients with peri-implant mucositis and peri-implant health. The results show that most patients with peri-implantitis do not have concomitant periodontitis.

Vague statement: Specify what kind of "relevance" is being considered.

Investigations into peri-implant biofilms consider the relevance of implant-related environmental factors. These factors play a crucial role in facilitating effective, implant-driven therapies for peri-implantitis, which are essential for mitigating the health burden associated with implant-related inflammatory conditions *(Kotsakis & Olmedo, 2021)*. The architectural characteristics of dental implants differ from those of natural teeth, including differences in morphology, surface material, texture, and energy *(Robitaille et al., 2016)*. Furthermore, dental implants differ from natural teeth by being decay-resistant, lacking pulps that could serve as early pathology indicators or contribute to endodontic lesions, and lacking a periodontal membrane *(Misch, 2014)*. Periodontal tissues attach teeth to alveolar bone via the periodontal ligament and supra-bony connective tissues, which include collagen fibers anchored to the root's cementum. In contrast, osseointegrated dental implants lack these connective tissue attachments, with direct bone contact and no intervening connective tissues *(Klokkevold & Newman, 2000)*. When comparing implants to natural teeth, implants are typically conical screws made of titanium and/or ceramic, known for their increased surface roughness and decreased surface energy. Although roughness, energy, and composition are interrelated, each factor can independently influence bacterial colonization, gene expression, and community composition *(Larsson et al., 2022)*. The presence of peri-implantitis in implants led to significantly elevated amounts of dissolved titanium in subgingival plaque compared to healthy implants. This indicates a strong association between titanium dissolution and peri-implantitis *(Kotsakis, Olmedo, 2021)*. Furthermore, the combination of stress, corrosion, and bacteria can also contribute to implant failure *(Chaturvedi, 2009)*. Tribocorrosion and metal corrosion impact peri-implant biofilms, potentially leading to peri-implant inflammation and implant failure through

Abrupt transition: This sentence doesn't flow well from the previous one.

direct mechanisms (such as immune modulation) or indirect pathways (by disturbing the microbiome) *(Kotsakis & Olmedo, 2021)*. Additional investigation is required to elucidate the factors behind titanium dissolution and the role of titanium corrosion byproducts in the progression of peri-implant inflammation *(Safioti, 2017)*. According to the limited clinical data, the incidence and development of peri-implantitis do not differ between modified and non-modified implant surfaces *(Schwarz et al., 2021)*. Differences in the implant and natural tooth environment affect the simultaneous occurrence of periodontal and peri-implant diseases. In this study, these differences led to the occurrence of not only periodontitis but also gingivitis with peri-implantitis.

Meffert et al. *(Meffert, 1996)* reported that the bacterial flora linked to the implant and native tooth during illness are mostly identical and consist primarily of gram-negative pathogens, including *P. gingivalis*, *Porphyromonas intermedia*, and *A. actinomycetemcomitans*. It indicates that the subgingival microbiota compositions are quite comparable between the distinct clinical groups of periodontitis and peri-implantitis. These similarities encompass potential "periodontopathogens" like *Prevotella*, *Porphyromonas*, *Tannerella*, *Bacteroidetes* [G5], and *Treponema* spp. *(Yu et al., 2019)*. In contrast, Dutra et al. *(Dutra et al, 2023)* observed a varied array of bacteria near infected implants, some of which were unculturable and previously unidentified. The presence of bacteria unrelated to periodontitis could instigate inflammation in the peri-implant tissues, highlighting notable distinctions in the microbiota between periodontal and peri-implant regions. Also, a higher prevalence of opportunistic pathogens, such as Staphylococcus and Candida species, characterizes the microbiome associated with peri-implantitis *(Iuşan et al., 2022)*. The structure of biofilms in peri-implantitis is more intricate compared to that in periodontitis. Although various bacterial species have been identified as potential pathogens in peri-implantitis, periodontopathogenic bacteria are less prevalent *(Koyanagi et al., 2013)*. In periodontitis, bacteria from the red complex are vital pathogens, whereas they are not prevalent in peri-implant biofilms. There might be a confirmation bias in the dissemination of information regarding their presence *(Kotsakis & Olmedo, 2021)*. Another study revealed no discernible difference in the occurrence of periodontal bacteria around implant sites in patients with peri-implant mucositis compared with patients with gingivitis *(Salvi et al., 2022)*. Host-bacterial interactions shape unique microbiomes in both periodontal and peri-implant environments, indicating differences in microbial composition associated with health

and disease, both individually and at the core microbiome level. However, diseases can facilitate the migration of periodontal bacteria into peri-implant sulci, or periodontitis can progress to peri-implantitis *(Robitaille et al., 2016)*. In this study, individuals diagnosed with peri-implant mucositis had concomitant gingivitis, while gingivitis was detected in most patients presenting with peri-implantitis due to these differences.

Various alterations in microbial populations influence the initiation and advancement of inflammatory reactions surrounding both natural teeth and dental implants. Furthermore, prior occurrences of periodontal disease exert an additional influence on modifying the immune reactions of peri-implant and periodontal tissues in response to the accumulation of biofilms *(Dutra et al, 2023)*. The majority of the cells in both entities tend to be plasma cells and lymphocytes. However, neutrophil granulocytes and macrophages have been reported to be more abundant in patients with peri-implantitis than those with periodontitis *(Berglundh et al., 2011)*. Implant plaque control effectively inhibits the formation of bacterial plaques on titanium abutments. The absence of inflammatory cell infiltrates in the peri-implant mucosa further highlights the ability of the junctional epithelium at titanium surfaces to form a barrier, preventing the formation of a subgingival infection in the absence of supragingival plaque *(Berglundh et al, 1991)*. The expression of mRNA levels for IL-6 and IL-1β is observed to elevate in tissues afflicted by both periodontal disease and peri-implantitis. However, no significant difference was detected in the expression of metalloproteinases and their inhibitors among the studied groups *(Figueiredo et al., 2020)*. Conversely, soft tissues around implants likely trigger more enhanced host immune responses, such as dominant macrophage infiltration, to promote osteoclastogenesis than those in periodontitis in another study *(Yuan et al., 2022)*. In addition, IL-1 and TNF-α serve as sensitive indicators of bone loss adjacent to both natural teeth and dental implants *(Machtei, Oved-Peleg & Peled, 2006)*. Salvi et al. *(Salvi et al., 2022)* similarly reported that IL-1β levels were the same in their study, while MMP-8 levels were greater around the peri-implant region. Although peri-implantitis and periodontitis share similarities in clinical presentation and etiology, significant histopathological distinctions differentiate these two conditions *(Berglundh et al., 2011)*. These significant histopathologic differences may affect the incidence of peri-implantitis and periodontitis at the same time. This study supports this situation.

Genetic variations in the Fmlp Receptor (FPR1) gene are strongly linked to a higher susceptibility to periodontitis and peri-implantitis *(Turkmen & Firatli, 2022)*. The genetic variation within the IL-17A gene may potentially influence the predisposition to peri-implant diseases *(Talib & Taha, 2024)*. Also, the alleles 1 and 2 of the IL1A gene and the alleles 1 and 2 of the IL1B gene were statistically associated with the success or no success of the dental implants *(Vaz et al., 2012)*. Ten genetic polymorphisms of inflammation-related molecules, including pro-inflammatory cytokines and protease inhibitors, may have substantially influenced periodontitis. An individual may inherit several relatively common high-risk polymorphisms, resulting in a cumulative high-susceptibility profile for periodontitis *(Kinane, Hart, 2003)*. To date, specific genetic variations consistently associated with periodontitis in certain populations encompass those within ANRIL, COX2, IL1, IL10, and DEFB1 genes. However, many proposed candidate genes for periodontitis lack robust validation or replication *(Loos et al., 2015)*. According to a study, individuals carrying the G genotype exhibit an increased susceptibility to periodontitis, while those with the G/C genotype demonstrate a greater risk of peri-implantitis *(Turkmen, Firatli, 2022)*. With the effect of the differentiation of the genetic profile in peri-implantitis and periodontitis, periodontitis may not be seen in every patient with peri-implantitis, as seen in the study.

Substantial evidence suggests an elevated risk of peri-implantitis among individuals with a previous history of chronic periodontitis, inadequate plaque control proficiency, or lack of consistent post-implant therapy maintenance *(Schwarz et al., 2018)*. Additionally, robust evidence indicates that periodontitis amplifies the probability of implant loss. Moreover, there exists moderate evidence suggesting that individuals affected by periodontitis exhibit elevated rates of implant-bone loss, thus establishing this condition as a predisposing factor for peri-implantitis *(Shiba T et al., 2021)*. Although the presence of periodontitis is a serious risk factor for peri-implantitis, this is not always the case, as found in this study.

Furthermore, it is imperative to consider immunological and histopathological distinctions when devising treatment strategies for peri-implantitis and periodontitis *(Berglundh et al., 2011)*. Following non-surgical interventions, the microbial makeup of periodontal and peri-implant sites is observed to undergo comparable alterations, transitioning from an abundance of periodontal pathogens to a composition akin to healthy sites *(Shiba T et al., 2021)*. Notably, in implants

featuring rough surfaces, a previous history of periodontal disease detrimentally affects survival rates, despite undergoing scaling and root planing procedures *(Young et al., 2021)*. There were also reports of disease progression or recurrence, as well as implant loss despite treatment *(Heitz-Mayfield, Mombelli, 2014)*. Microbial, genetic, and immunologic differences in peri-implantitis and periodontitis are reflected in treating these diseases. The study's results support these differences, and a personalized approach is considered more appropriate in treating peri-implantitis.

This study has several limitations and strengths worth noting. A key limitation is the potential selection bias, as the sample was drawn from a single university clinic and may not represent the broader population. Although random sampling and strict inclusion and exclusion criteria were employed, some bias might still exist. Additionally, the cross-sectional design limits the ability to establish causal relationships between peri-implant and periodontal conditions. Despite these limitations, the study has notable strengths, including the use of well-established diagnostic criteria from the 2017 AAP/EFP World Workshop on Classification of Periodontal and Peri-implant Diseases and Conditions, ensuring consistent and reliable assessments. The comprehensive data collection by a single clinician, which included various indices such as plaque index, gingival index, probing depth, bleeding on probing, clinical attachment loss (CAL), and gingival recession, provides a thorough evaluation of the conditions. Importantly, the study contributes valuable insights into the co-occurrence of peri-implant and periodontal conditions, particularly highlighting that peri-implantitis is often absent in patients with periodontitis, suggesting a complex relationship between implant treatment and periodontal health that warrants further investigation.

Conclusions

This study tested whether peri-implant and periodontal conditions occur simultaneously and found that most patients with peri-implantitis did not have concomitant periodontitis. Clinically, these results indicate that peri-implant and periodontal conditions should be evaluated and treated independently, emphasizing preventive care, regular monitoring, and patient education on rigorous oral hygiene practices, while future research should explore the underlying mechanisms differentiating peri-implantitis from periodontitis to develop targeted therapies and improved management strategies for patients with dental implants.

Decleratation

Ethics approval and consent to participate

Bolu Abant İzzet Baysal University Clinical Researches Ethics Committee approved the study (2022/163-28/06/2022). Participants were informed verbally and in writing about the design of the study. The study was conducted with respect to the Helsinki Declaration. The informed consent form was obtained from all participants.

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Table 1(on next page)

Demographic characteristics of participants

		f	%
Gender	Male	70	57.1
	Female	53	42.9
Education	Elementary School	27	21.4
	Middle School	14	11.4
	High School	33	25.7
	University	49	40.0
Work status	Working	85	68.5
	Nonworker	9	7.1
	Retired	29	22.9
		Mean±S.D	**Min-Max**
Age		51.37±10.64	26-72

Table 1: Demographic characteristics of participants

Table 2(on next page)

Demographic characteristics of participants

Table 2: Distribution of examination groups

		f	%
Peri-implant group	Peri-implantitis	41	33.3
	Peri-implant mucositis	41	33.3
	Peri-implant health	41	33.3
Periodontal group	Gingivitis	55	44.7
	Periodontitis	18	14.6
	Periodontal health	50	40.7
	Total	123	100.0

Table 3(on next page)

Comparison of peri-implant and periodontal groups

Table 3: Comparison of peri-implant and periodontal groups

		Peri-implant Group				
		Peri-implantitis	**Peri-implant mucositis**	**Peri-implant health**	**Total**	**p**
Periodontal Group	**Gingivitis**	17 41.5% [a]	21 51.2% [a]	17 41.5% [a]	55 44.7%	0.003*
	Periodontitis	13 31.7% [a]	2 4.9% [b]	3 7.3% [b]	18 14.6%	
	Periodontal health	11 26.8% [a]	18 43.9% [b]	21 51.2% [b]	50 40.7%	
Total		41 100.0%	41 100.0%	41 100.0%	123 100.0%	

Table 4(on next page)

Comparison of index values in implant and periodontal evaluation

Table 4: Comparison of index values in implant and periodontal evaluation

		İmplant index		Periodontal index		p
		Mean±S.D.	**95% CI (L-U)**	**Mean±S.D.**	**95% CI (L-U)**	
Plaque index	Peri-implantitis	0.13±0.31	0.03-0.23	0.36±0.48	0.21-0.52	0.001*
	Peri-implant mucositis	0.09±0.24	0.01-0.16	0.21±0.22	0.15-0.28	0.002*
	Peri-implant health	0.06±0.14	0.02-0.10	0.16±0.19	0.10-0.22	0.025*
	Total	0.09±0.24	0.05-0.13	0.24±0.33	0.19-0.30	0.001*
Gingival index	Peri-implantitis	0.42±1.09	0.07-0.76	0.11±0,11	0.07-0.14	0.001*
	Peri-implant mucositis	0.26±0.50	0.10-0.42	0.14±0,17	0.08-0.19	0.023*
	Peri-implant health	0.16±0.42	0.02-0.29	0.09±0.16	0.04-0.15	0.412
	Total	0.28±0.74	0.15-0.41	0.11±0.15	0.09-0.14	0.001*
Probing on depth	Peri-implantitis	3.91±2.14	3.24-4.59	2.17±0.26	2.09-2,25	0.001*
	Peri-implant mucositis	2.14±0.44	2.00-2.28	1.98±0.88	1.70-2.26	0.165
	Peri-implant health	1.97±0.48	1.82-2.12	2.06±0.25	1.98-2.14	0.837
	Total	2.67±1.55	2.40-2,95	2.07±0.55	1.97-2.17	0.006*
Bleeding on probing	Peri-implantitis	0.66±0.37	0.54-0.78	0.23±0.25	0.15-0.31	0.001*
	Peri-implant mucositis	0.62±0.29	0.53-0.71	0.18±0.15	0.13-0.23	0.001*
	Peri-implant health	0.00±0.02	0.00-0.01	0.14±0.18	0.09-0.20	0.001*
	Total	0.43±0.40	0.36-0.50	0.18±0.20	0.15-0.22	0.001*
Gingival recession	Peri-implantitis	0.72±1,41	0.27-1.17	0.19±0.38	0.06-0.31	0.001*
	Peri-implant mucositis	0.25±0.66	0.04-0.46	0.12±0.20	0.05-0.18	0.014*
	Peri-implant health	0.16±0.42	0.02-0.29	0.23±0.47	0.08-0.38	0.410
	Total	0.38±0.96	0.20-0.55	0.18±0.37	0.11-0.24	0.001*
Clinical attachment level	Peri-implantitis	3.97±2.21	3.28-4.67	2.28±0.36	2.16-2.39	0.001*
	Peri-implant mucositis	2.09±0.55	1.92-2.26	1.98±1.02	1.66-2.30	0.869
	Peri-implant health	1.98±0.61	1.79-2.17	2.02±0.68	1.80-2.23	0.971
	Total	2.68±1.63	2.39-2.97	2.09±0.74	1.96-2.22	0.001*

95% Confidence Interval (Lower Bound-Upper Bound)

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