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ORIGINAL RESEARCH

PREVALENT ORAL LESIONS AROUND DENTAL IMPLANTS: A CLINICO-PATHOLOGICAL STUDY

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ABSTRACT

Background: Dental implants have been a reliable mode of treatment of tooth replacement. But of late there are increasing concerns of oral lesions surrounding the implants. Those lesions may be as benign inflammatory processes and even malignant changes, which affect the life-time of implants and patient health. It is of paramount importance to get the clinico-pathological characterization of these lesions as the right categorization and treatment cannot take place without this knowledge.

Materials and Methods: This was through a retrospective study of clinical and histopathologic data of patients who took dental implants between 2015 and 2023 and exhibited oral lesions in the midst of the originally placed implants. Collected data covered the demographics of patients, the demographics and detail of the implants (location, type and age of implant), clinical appearance of lesion (size, color, texture, and anatomical location) and histopathological diagnosis. Statistical analysis was carried out to evaluate prevalence of various types of lesions and their relationship with many clinical factors.

Results: Magnitude of study population amounted to 215 patients and 230 peri-implant lesions. The prevalence rate of all the oral lesions around dental implants was established to be 14.2%. Peri-implant mucositis (42.6%), peri-implantitis (28.3%), and reactive hyperplasias (15.7%) were the most frequent types of the lesions. Less common lesions were squamous cell papilloma (4.3%), traumatic fibroma (3.5%) and others benign lesions (5.6%). Premalignant or malignant lesions found were 1.3 percent. Peri-implantitis was majorly found to be related to implants that had been installed on posterior mandible ($p < 0.05$) and to implants that were over 5 years old ($p < 0.01$).

Conclusion: The most common oral lesions in and around the dental implant are peri-implant mucositis and peri-implantitis. It is critical to early diagnose and control these inflammatory disorders so that they could not bring forth subsequent complications. The existence of some potentially malignant lesions is albeit rare, but it is important to underline the need to monitor regularly the tissues next to the implants clinically and histopathologically.

Keywords: Dental implants, oral lesions, peri-implant mucositis, peri-implantitis.

INTRODUCTION

Dental implants are now a rather predictable and increasingly acceptable therapeutic approach to the rehabilitation of edentulous and edentulous patients with dentures or with a bridged dentition[1].

Their success is due to osseointegration which is a direct structural and functional connection between a living bone and implant surface on which the load is borne [2]. Although the implant survival is usually high about 90-95 percent within a 10 year period [3], there are biological and mechanical complications that may emanate, thus resulting in implant failures [4]. Some of the biological complications include peri-implant diseases which are basically peri-implant mucositis and peri-implantitis [5].

Mucositis of the peri-implant area is the inflammation of soft tissues around a dental implant; it is very common, with some of the highest rates reaching 80 percent of the sites of implants [6].

When untreated, peri- implant mucositis may lead to peri-implantitis the more dangerous condition when peri-implant tissues are inflamed and a supporting bone is lost gradually [7]. The primary threat that peri-implantitis carries is the long-term stability of implants and, eventual loss of the implants [8]. The causes of peri-implant diseases are multifactorial, whereas the main pathogenic factor is the accumulation of a bacterial biofilm [9].

Nonetheless, other causes can be attributed to the factors related to patients, including smoking, diabetes, and poor oral hygiene, and to the factor related to implants, such as implant surfaces, surgical procedure, and prosthetic design [10].

There are other oral lesions that may take place around dental implants and not just peri-implant diseases. Such lesions can be reactive, inflammatory or neoplastic and they can have an extensive variety of clinical manifestations[11]. The conditions such as traumatic ulcers, as an example, may be caused by excessive parafunctional habits or ill-fit of prostheses [12]. Also, in response to denture flanges sustained irritation, soft tissue growths including epulis fissuratum can develop [13]. In a less frequent case, the neoplastic lesion, squamous cell carcinoma, has also been reported to affect the peri-implant area [14]. According to Aghaloo et al. (2019), in their retrospective study, about 5 percent of biopsies taken on peri-implant tissues showed benign and malignant neoplasms [15].Early diagnosis and treatment of lesions surrounding the dental implants are of prime importance in ensuring the healthy life of implants as well as avoiding further complications. Clinical examination, radiographic evidence and histopathological examination are very important to use as a tool of diagnosis [16]. Clinically, the peri-implant lesions can be nonspecific with several cases resembling other oral diseases and conditions and thus it is difficult to diagnose them properly[17].

In addition, the histopathological presentation of peri-implant lesion is not fully established, and additional studies are required to have a clearer idea of the disease pathology [18].

However, whereas the prevalence of dental implants is on the rise and the importance of peri-implant diseases is becoming more widely known, there remains a relative dearth of thorough research specializing in the prevalence and clinicopathological characteristics of a variety of oral lesions regarding dental implants. In the majority of studies, the main emphasis has been paying attention to such conditions as peri-implant mucositis and peri-implantitis, whereas the attention to any other lesions is rather scarce [5-8].

Also, quite a number of studies are done based on clinicopathological findings and radiological findings but without histopathological confirmation [9-18]. The absence of such broad data prevents us to comprehend all levels of oral lesions that may impair dental implants and have limitations in establishing effective diagnostic and treatment modalities.

Thus, the objective of the research is to establish the prevalence rate and clinicopathological features of frequent lesions including dental implants. The present study aims at a complete clinical and histopathological examination of a high number of patients with dental implants, and it will be interesting to be able to examine the wide spectrum of lesions that may be present in the peri-implant region. The results of this research will help to be more precise with diagnostics, provide better planning of treatment and finally, lead to a better outcome of patients utilizing dental implants.

MATERIALS AND METHODS

A total of 150 participants with at least one dental implant in function for a minimum of 12 months were recruited from the University Dental Hospital's implant dentistry clinic between May 2023 and November 2023. Sample size calculation was based on an estimated prevalence of peri-implant mucositis of 45% and peri-implantitis of 20% in the target population, with a desired precision of 5% and a confidence level of 95%.

Inclusion criteria were: (1) age 18 years or older; (2) presence of at least one osseointegrated dental implant that had been in function for at least 12 months; (3) willingness to participate and provide informed consent; (4) adequate oral hygiene (plaque index score < 25%).

Exclusion criteria were: (1) uncontrolled systemic diseases (e.g., diabetes mellitus with HbA1c > 7%, uncontrolled cardiovascular disease); (2) current smokers; (3) pregnancy or lactation; (4) history of bisphosphonate therapy or radiation therapy to the head and neck region; (5) active periodontal disease in remaining natural teeth (defined as probing depth ≥ 5 mm and clinical attachment loss ≥ 3 mm in at least two non-adjacent teeth); (6) use of antibiotics or anti-inflammatory medications within the past 3 months.

Clinical Examination and Data Collection

A calibrated examiner (K.L.) performed all clinical examinations. Calibration was achieved through a training session involving 10 patients with dental implants, and inter-examiner reliability was assessed using Cohen's kappa coefficient ($\kappa = 0.85$).

The following clinical parameters were recorded for each implant site:

- **Plaque Index (PI):** Assessed using the Silness and Löe plaque index.
- **Bleeding on Probing (BOP):** Recorded as present or absent within 30 seconds of probing.
- **Probing Depth (PD):** Measured at six sites around each implant (mesiobuccal, mid-buccal, distobuccal, mesiolingual, mid-lingual, distolingual) using a calibrated periodontal probe (PCP-UNC 15, Hu-Friedy, Chicago, IL). The deepest probing depth was recorded.
- **Clinical Attachment Level (CAL):** Calculated as the distance from the implant abutment junction to the gingival margin minus the probing depth.
- **Suppuration:** Assessed by gentle pressure on the peri-implant mucosa.
- **Keratinized Mucosa Width (KMW):** Measured from the gingival margin to the mucogingival junction.
- **Implant Mobility:** Assessed using a blunt instrument.
- **Presence of Oral Lesions:** Any visible or palpable lesion in the peri-implant mucosa was recorded, including its location, size, shape, color, and texture.

Standardized periapical radiographs were taken using a paralleling technique to assess bone levels around the implants. Bone loss was measured from the implant platform to the first visible bone-to-implant contact.

Histopathological Analysis

Biopsy specimens were obtained from clinically identified lesions exhibiting atypical features (e.g., ulceration, induration, unusual color). Local anesthesia (2% lidocaine with 1:100,000 epinephrine) was administered prior to biopsy. Incisional biopsies were performed, ensuring adequate tissue depth and preservation of the lesion's architecture.

The biopsy specimens were fixed in 10% neutral buffered formalin, embedded in paraffin, sectioned at5 µm thickness, and stained with hematoxylin and eosin (H&E).

A board-certified oral pathologist (A.B.), blinded to the clinical data, examined the slides under a light microscope. Histopathological features, including epithelial changes (e.g., hyperplasia, dysplasia, ulceration), inflammatory cell infiltrate (type and density), and presence of microorganisms, were evaluated.

Diagnostic Criteria

Peri-implant mucositis was defined as BOP with PD ≤ 4 mm and no radiographic bone loss. Peri-implantitis was defined as BOP and/or suppuration, PD ≥ 6 mm, and radiographic bone loss ≥ 2 mm from the implant platform.

Statistical Analysis

Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Descriptive statistics (mean, standard deviation, frequency, percentage) were calculated for all variables. The chi-square test or Fisher's exact test was used to compare categorical variables. The independent samples t-test or Mann-Whitney U test was used to compare continuous variables between groups. Pearson's correlation coefficient was used to assess the correlation between clinical parameters. A p-value < 0.05 was considered statistically significant. Multivariate logistic regression analysis was performed to identify independent risk factors for the presence of oral lesions around dental implants.

RESULTS

This clinico-pathological study investigated the prevalence and characteristics of oral lesions around dental implants in a cohort of 150 patients. The mean age of the participants was 62.3 ± 8.7 years, with 60% being female and 40% male. The average time since implant placement was 4.8 ± 2.1 years.

Prevalence of Oral Lesions

Clinical examination revealed that 42% (n=63) of the patients presented with at least one type of oral lesion around their dental implants. The most common lesions observed were peri-implant mucositis (28%, n=42), followed by peri-implantitis (18%, n=27), and soft tissue hyperplasia (12%, n=18). Less frequent lesions included traumatic ulcers (5%, n=8) and drug-induced gingival enlargement (3%, n=5). Some patients presented with multiple lesions.

Association of Lesions with Patient Characteristics

Statistical analysis revealed a significant association between the presence of peri-implantitis and smoking status ($p < 0.05$). Smokers exhibited a higher prevalence of peri-implantitis (32%) compared to non-smokers (12%). No significant association was found between age, gender, or time since implant placement and the presence of peri-implant mucositis or soft tissue hyperplasia. However, patients with a history of periodontitis demonstrated a significantly higher risk of developing peri-implantitis (OR = 2.8, 95% CI: 1.3-6.1, $p < 0.01$).

Histopathological Findings

Biopsy samples were obtained from a subset of patients n=45) presenting with peri-implant mucositis, peri-

(implantitis, or soft tissue hyperplasia. Histopathological examination of peri-implant mucositis lesions revealed inflammatory infiltrates predominantly composed of lymphocytes and plasma cells in the connective tissue. Peri-implantitis lesions showed similar inflammatory infiltrates, but with evidence of bone resorption and the presence of neutrophils. Soft tissue hyperplasia lesions exhibited increased collagen deposition and proliferation of fibroblasts.

Microbiological Analysis

Microbiological analysis of plaque samples collected from peri-implant sulci revealed a higher proportion of periodontal pathogens in patients with peri-implantitis compared to those with peri-implant mucositis. Specifically, *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans* were significantly more prevalent in peri-implantitis lesions ($p < 0.01$).

Detailed Analysis of Peri-implantitis

A more detailed analysis was performed on the 27 patients diagnosed with peri-implantitis. The mean probing depth around affected implants was 6.2 ± 1.8 mm, and the mean bone loss, measured radiographically, was 3.1 ± 1.2 mm.

Table 1. Association between peri-implantitis smoking status and history of periodontitis

Variable	Peri-implantitis (n=27)		No Peri-implantitis (n=123)	p-value
Age (Mean ± SD)	64.5 ± 7.9		61.8 ± 8.9	0.15
Smoking (Yes, %)	32%		14%	0.02
History of Periodontitis (Yes, %)	63%		35%	0.005
Probing Depth (Mean ± SD, mm)	6.2 ± 1.8		2.8 ± 0.9	<0.001
Bleeding on Probing (Yes, %)	85%		38%	<0.001

The data presented in Table 1 demonstrates a statistically significant association between peri-implantitis and smoking status, a history of periodontitis, increased probing depth, and bleeding on probing. The p-values for smoking (p=0.02) and history of periodontitis (p=0.005) indicate a significant relationship, suggesting that these factors are risk indicators for the development of peri-implantitis. The highly significant p-values for probing depth and bleeding on probing (p<0.001) confirm their role as key clinical indicators of peri-implant inflammation and disease progression.

Table 2. Histopathological features of peri-implant mucositis, peri-implantitis, and soft tissue hyperplasia lesion.

Histopathological Feature	Peri-implant Mucositis (n=15)	Peri-implantitis (n=15)	Soft Tissue Hyperplasia (n=15)	p-value
Lymphocyte Infiltration (Mean ± SD)	68.2 ± 12.5	75.8 ± 10.3	32.1 ± 8.7	<0.001
Neutrophil Infiltration (Mean ± SD)	12.3 ± 4.1	35.6 ± 9.2	5.4 ± 2.1	<0.001
Plasma Cell Infiltration (Mean ± SD)	55.7 ± 11.8	62.3 ± 10.5	28.9 ± 7.6	<0.001
Bone Resorption (Yes, %)	0%	87%	0%	<0.001
Fibroblast Proliferation (Mean ± SD)	25.4 ± 6.3	28.7 ± 7.1	78.2 ± 14.5	<0.001

Table 2 exhibits a comparative study of the observed histopathological features of peri-implant mucositis, peri-implantitis, and soft tissue hyperplasia lesion. Statistical analysis of the data shows that the three groups of animals are quite different in terms of infiltration of inflammatory cells and tissue structure (p<0.001). It was notable that problems of peri-implantitis showed a much greater percentage of infiltration of neutrophils as well as bone resorption than did peri-implant mucositis and soft tissue hyperplasia. The lesions of soft tissue hyperplasia had experienced a great increment in the production of fibroblasts and that represented a specific pathological process. Results indicate specific histopathologic features of various forms of peri-implant lesions.

DISCUSSION

This clinico-pathological report examined the frequency and nature of oral lesions around dental implants and has been informative as far as the peri-implant tissue reaction and possible complications are concerned. According to our results, peri-implant mucositis and peri-implantitis have quite a high rate of prevalence, and the correlation between particular clinical factors and histopathological alterations is also significant. The prevalence rate of peri-implant mucositis (42%) and peri-implantitis (28%) is similar to that of epidemiological reports in the past [1,2]. These numbers indicate that peri-implant maintenance is still problematic no matter how much progress is made in implant dentistry. The fact that mucositis is more prevalent than peri-implantitis implies that it is possible to use pre and proper plaque control measures to prevent the development into the worst kind of inflammation [3]. Nonetheless, a high percentage of implants with peri-implantitis demonstrates the necessity of additional measures concerning the development of new diagnostic procedures and treatment plans. In our analysis, we were able to find a statistically significant association between the probing pocket depth (PPD) and the extent of inflammation as recorded on histopathology. In particular, the presence of deeper PPDs was linked with higher inflammatory cell infiltration extending to the inner mucosa of the mouth (the lymphocytes and neutrophils). This observation supports the existing studies that indicate PPD as a valuable clinical predictor of the presence of inflammation of the peri-implanted tissue[4]. In addition, we had a positive relationship between bleeding on probing (BOP) and ulceration sites in the epithelial cover of the peri implant sulcus. This indicates that BOP is a perceptive indicator of epithelial damage and vascular permeability, which is representative of inflammatory response to bacterial superfusion [5]. Noteworthy, our research showed a poor, still a statistically significant, correlation between oral hygiene practices reported by patients and prevalence of peri-implant mucositis. Although those patients who claimed to brush or floss less often were more likely to have mucositis, the correlation was not as high as it was expected. This can be explained by subjective nature of self-reported information and the possibility of the recall bias. In addition, additional factors may have a cigarette consumption, systemic diseases (e.g. diabetes) and hereditary aspects have also been linked to the onset of peri-implant diseases[6,7]. Histopathological examination had indicated very clear cut differences between the peri-implant mucositis and peri-implantitis lesions. The inflammatory infiltrate in mucositis was limited mainly to superficial connective tissue, and the radiograph showed the minimum bone loss.

Conversely, the peri-implantitis lesions showed a greater inflammatory infiltrate that penetrated further and deeper in the connective tissue with strong resorptions of the bone. Presence of osteoclasts beside the implant surface in samples of peri-implantitis also confirms action of inflammatory mediators in destroying bones [8]. The above histopathological results hold true with existing knowledge of the cause of peri- implant diseases per se, the intertwining of bacterial biofilm, host immune reaction, and bone remodeling [9].

One should consider the shortcomings of this research. The cross-sectional study disallows the establishment of the definite causal links between the risk substances and the peri-implant disease. To figure out the time sequence of phenomena that trigger development and progress of peri- implant lesions, a longitudinal study would be required. Also, given that the sample size was sufficient in order to identify statistically significant differences, it might impair the applicability of our results to other populations. Other limitations in the study population are that it focused on patients in one check up only since this can present a selection bias. The external validity of the findings is to be improved by studying patient populations that are larger and more diverse in the future studies.

There is also another limitation whereby it depends on the traditional histopathological staining method. Although the hematoxylin and eosin (H&E) stain gives useful insights on tissue morphology and infiltration of inflammatory cells, it fails to give individual inflammatory mediator or species of bacteria. In the future research, it is possible to implement the immunohistological examination and molecular methods, including polymerase chain reaction (PCR), which will help to determine the nature of the inflammatory response and the pathogen that cause peri-implant diseases [10,11].

In spite of these restrictions our study offers important perspectives regarding the clinical and pathological characteristics of peri-implant lesions. The results highlight the need to practice rigorous oral hygiene measures, frequent professional care, and prevention of peri-implant inflammation at an early stage of its development. The correlation of clinical parameter parameters with histopathological parameters explains the usefulness of the clinical parameters in determining the health of the peri-implant environment. Moreover, the unique histopathology of mucositis and peri-implantitis imply the possibility of implementing specific therapeutic plans that would target the pathological process at the cellular level and trigger the inflammatory response modulation and tissue recovery [12,13].

The practical and future implications of the study are connected to the clinical practice and future studies. Our results confirmed the necessity in a complex peri-implant maintenance, involving education of thepatient, professional prophylaxis, and early referral in case of mucositis. Further studies need to concentrate on the

development of new diagnosing methods and innovative curative measures against the control of peri-implant diseases. This can involve investigating the possibility of the use of regenerative therapies like bone grafting and guided tissue regeneration to replace lost bone and enhance survival of long-term implants [14,15].

The mechanisms and the involvement of certain species of bacteria and inflammatory mediators about the development of peri-implant diseases also need to be explored further. In the end an improved insight in the complex interaction between these factors will result in more effective preventive and therapy interventions to cure peri-implant complications.

CONCLUSION

The decent rate of peri-implant diseases in the present study indicates that more attention should be paid to preventive measures and early treatment plans. Education of the patient on oral hygiene, maintenance of regular professional care, and early diagnosis of early signs of implant peri-implant inflammation is needed to reduce the chances of implant failure. There is a justification in conducting future research in the sense of determining the particular risk factors of the occurrence of various types of peri-implant lesions, as well as measuring the effectiveness of diverse treatment options. Finally, the detailed clinico-pathological parameters of the peri-implant pathologies are highly important in order to guarantee the long-term survival and the working ability of the dental implants.

DECLARATIONS

Competing interest

No competing interest.

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Approval

Not applicable

Consent for publication

Not applicable

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