



### Evaluation of the etiology of Peri-implantitis; A narrative review

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#### Abstract

**Background:** Peri-implantitis is a situation that begins as gingival inflammation around a dental implant (peri-implant mucositis) and then extends to the bone which supports; dental implant. It causes bone loss at the coronal part of the fixture and can be determined by deep gingival pockets, bleeding, or discharge during investigation. Learning how to find, understand the etiology, assess the progress, find out its prevalence, and manage peri-implantitis is very essential for both dental students and residents.

**Objectives:** This study aimed to search the different factors that stimulate the onset of peri-implantitis, with the intention of using this knowledge to support practical prevention techniques.

**Methods:** A comprehensive survey of previous studies was done using two main online sources: PubMed and Google Scholar. PubMed showed 1,512 beneficial articles, while Google Scholar gave a much higher numbers, with 7,940 relevant findings.

**Results:** Periodontal disease, inadequate supportive therapy, and cigarette smoking are recognized as significant systemic risk factors contributing to the development of peri-implantitis. Local factors such as poor plaque control, mucosal inflammation,

Improperly designed implant crowns, residual submucosal cement, and lack of keratinized mucosa surrounding the implant also play critical roles in increasing the risk of peri-implantitis. Effective management of both systemic and local risk factors is essential to prevent and control this condition.

**Conclusion:** In conclusion peri-implantitis is a broad and complex condition caused by several variables. The main causes of it are past history of periodontal disease, smoking, patient incompletion for regular checkup, poor cleaning habits, rough implant surface and residual cement around implant interface.

**Keywords:** Peri-implantitis, Etiology, Peri-mucositis and risk factors.

#### Introduction

A gum problem around dental implants caused by plaque which can be treated and reversed is called Peri-implant mucositis. It affects only the soft tissue and often shows signs like redness, swelling and bleeding when touch gently. If this situation not treated, it can worsen and turn into peri-implantitis, when the infection spreads deeper and starts damaging the supporting bone of implant. This condition is characterized by increased pocket depth, bleeding on probing and discharge, and loss of the bone-implant interface at the coronal part.[1]

Dental implants can also face problems like swelling and tissue damage just as gums and bones around natural teeth. These situation are called mucositis and peri-implantitis.1-3 sometimes, it is difficult for dentists to distinguish between them because they share similar signs. [4]

Bleeding when probing around an implant may indicate a potential issue, but there is not enough proof to say it can reliably predict future disease. [5]

Peri-implantitis is more severe than mucositis because it gets worse and cannot be reversed. It affects both the gingiva and the bone around the implant, breaks down the bone tissue, compromising the attachment

between implant and bone, forming deeper pockets around the implant, and sometimes resulting discharge of pus.<sup>1-3</sup> Bleeding, bone loss, and deep gingival pockets around an implant are not always caused by inflammation. For example, placing the implant too deep can also lead to these issues.<sup>6</sup> the health of the tissues around an implant can also be affected by several design features, such as the shape and type of the implant, how the parts are connected, and the materials and structure of the abutments and the attached crown or bridge.[5]

In the last three decades, peri-implantitis has become a major concern in modern dentistry. It is essential for dental students- both beginners and advanced- to learn how to recognize the condition, understand its underlying factors, monitor its development, be aware of its prevalence, and explore effective treatment approaches.[ 7]

A recent analysis by Mombelli and his team estimated that peri-implantitis impacts about 20% of individuals

With dental implant and 10% of the implant themselves. Still, these findings should be interpreted with caution due to heterogeneity among studies. The report also shows that bone alterations commonly happen into first few

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weeks after abutment placement, causing bone loss and that is normal and should not be considered as peri-implantitis. Therefore it is advised to take x-ray after the placement of the prosthetic part to have a baseline for assessing any future bone loss around the fixture.<sup>8</sup>

Many dangerous bacteria have been found in cases of peri-implantitis such as *Prevotella Nigrescens*, *Streptococcus constellatus*, *Aggregatibacter actinomycetem comitans*, *Porphyromonas gingivalis*, *Trepanoma denticola* and *Tannerella forsythia*.<sup>9,10</sup> Rams and colleagues revealed that from 120 patients, 71.7% were resistant to one or more kind of antimicrobial drugs.<sup>[10]</sup> Peri-implantitis is an infectious disease generated by different anaerobic bacteria, but, in contrast to periodontitis, it includes bacteria that are usually not related to gingival disease.<sup>[11]</sup> *Staphylococcus aureus* is firmly binds to titanium surfaces therefore it has an important role in the development of peri-implantitis. As reported by Salvi et al, it accurately predicts the condition with positive and negative predictive values of 80% and 90% respectively.<sup>[12]</sup> Also, inflammation around the implants with smooth surfaces develops more quickly than those with rough surfaces.<sup>[13,14,15]</sup>

Dental plaque is the main cause of peri-implantitis just like gingival disease.<sup>16</sup> Intact periodontium is influenced by various elements such as dental maintenance, oral health routine, gene expression alteration in gene activity, body health and nutritional habits.<sup>[17,18]</sup> Gram-negative anaerobic bacteria are linked with both peri-implantitis and periodontitis; nevertheless, peri-implantitis includes a broader range of microbes.<sup>[19]</sup> Immune cells like B-lymphocytes and plasma cells are present in the peri-implantitis area. Under microscopic examination, lesions of peri-implantitis are larger than periodontitis lesions, which shows increased blood vessel formation and a higher amount of cells in the connective tissue.<sup>[20]</sup> Concentration of Matrix metalloproteinase is 97% in peri-implantitis, which is greater than 78% observed in chronic periodontitis during comparing to healthy gingiva.<sup>[21]</sup> Tissue affected by peri-implantitis also includes antibodies targeting components of the extracellular matrix.<sup>[22]</sup> Peri-implantitis progresses more quickly, resulting bone loss that is faster and more intense than in periodontal disease. This fast bone loss could result from unique microbial populations around implants, body's different immune response, and the lack of keratinized tissue.<sup>[23,24]</sup>

Factors associated with higher chance of peri-implant disease include the plaque accumulation, smoking habits, history of periodontitis, implant design and surface topography, excess cement, an angled abutment greater than 30 degrees, exposure to radiation therapy, the thickness of keratinized tissue, interval after implant insertion, patient's gender and diabetic condition.<sup>[25-29]</sup> Another factor associated with development of peri-implantitis is occlusal overload,<sup>30</sup> history of implant failure, abnormal oral habits, and inappropriate direction of implant are also contributing factors.<sup>[31-33]</sup> Peri-implant mucositis is precursor for developing of peri-implantitis though there is limited data supporting link of systemic health condition directly to peri-implant mucositis risk. Connection between peri-implantitis and alcohol use is also supported by some studies. Additionally, systemic disorders like scleroderma, ectodermal dysplasia, lichen planus, osteoporosis, rheumatoid arthritis, and Sjögren's syndrome might have negative impact on peri-implantitis progression and the overall success of implants.<sup>[27,34]</sup>

A study by Denmark and Martin Saaby conducted in 2016, identified that cigarette smoking, periodontal disease, and improper fitting of crown margin are key risk factors contributing to peri-implantitis.<sup>[35]</sup>

According to Koldslund and co-researchers, individuals who have history of periodontitis are more prone to develop peri-implantitis.<sup>36</sup> This observation was confirmed in a recent systematic review presented by Carra et al.<sup>[37]</sup> and also highlighted in the consensus report from the 2017 World Workshop<sup>38</sup> and the connected review by Schwarz et al.<sup>39</sup> Patients with poor plaque control and who did not attend regular checkups show high incidence of peri-implantitis. Among risk factors, access for oral hygiene has

been emphasized to be an important element. Study by Serino G et al.<sup>40</sup> demonstrated that implants not accessible for oral hygiene aids had a high risk for peri-implantitis. In this study we want to determine the most prevalent cause of peri-Implantitis.

**Objective:** The aim of this study was to investigate the underlying causes of peri-implantitis and identify the most common contributing factor.

## Literature Review

Several study have been carry out about this subject which are listed below.

A study by Claudio Marcanito with his team revealed that peri-implantitis is relatively frequent condition, which are occurring in 4.7% of cases in 74% of implants and can reach to 8.9% in 55% of implant depending on diagnostic criteria and this condition is notably more prevalent in individual with a history of periodontal disease and smoking.<sup>[41]</sup>

In 2020 study Ciona Nobert and Hashimi Dena defined that peri-implantitis is prevalent condition with contributing of multiple factor such as periodontal disease, smoking, diabetes, obesity, furthermore there are some local factor which can proceed peri-implantitis such as mucosal inflammation, residual cement, inappropriate prosthesis.<sup>[42]</sup>

Stacchi Claudio and colleagues through a systematic review, assessed the influence of smoking and periodontal disease as risk factor in implant loss and peri-implantitis, their analysis concluded that the evidence support that periodontal disease is a direct risk factor for peri-implantitis is minimal.<sup>43</sup>

Although Mazel Anthony and his team using a systematic review and meta-analysis to demonstrate that peri-implantitis typically involve multiple causative factors and is linked to clinical symptoms such as excessive plaque accumulation, BOP and poor oral hygiene. This condition tend to be more common in individual undergoing treatment for periodontitis.<sup>44</sup>

In a 2019 study, Joerg Meyle and his colleagues noted that there is enough evidence to conclude that amount of general risk factors influence the short- and long-term success of implant treatment. Periodontal disease and long term stability affected significantly affected by smoking. Therefore, one of the important factor is a careful evaluation of patient's history.<sup>45</sup>

We should inform patients with history of periodontitis about increased risk for incidence of peri-implantitis. In the presence of periodontitis, successful management is very important in order to remove all local factors and maintain periodontal health before fixture insertion. In case there is not sufficient removal of local factor we should change time of implant placement to any other time.

Smokers and alcohol addiction should alter their habit or at least decrease the amount of smoking through counselling sessions to improve the long term success of dental implants. This should be accompanied by frequent visits to maintenance care to detect early changes in the periodontium.<sup>46</sup> In a 2016 systematic review by Claudio Stacchi and colleagues, identified whether previous periodontitis and smoking habits contribute to implant failure and the development of peri-implantitis. Their founf that a history of periodontitis is not a significant risk factor for implant failure. Additionally, the effect of smoking on periodontium health and implant failure remained inconclusive.<sup>43</sup>

## Research Questions

- 1-What is the etiology of peri-implantitis?
- 2.What are the most common causes of peri-implantitis?

## Key words

peri-implantitis, Etiology, peri-mucositis, risk factors

**Methodology:** A narrative literature search was conducted using two major databases, PubMed and Google Scholar. The search on PubMed identified a total of 1,512 relevant articles, while the search on Google Scholar returned a significantly larger number of results, amounting to 7,940 articles. The research is a narrative review, which was done using by

keywords peri-implantitis, etiology and risk factors of peri-implantitis on 20/11/2022.

#### Initial Database Search

• **Date of Search:** 20/11/2022

• **Keywords Used:** *Peri-implantitis, etiology, risk factors of peri-implantitis*

#### Databases Searched:



#### Screening Process

##### Title Screening:

5,000

To exclude irrelevant and duplicate articles

##### Abstract Reading:

1,500

To identify articles closely aligned with the study's objectives.

##### Full-Text Screening:

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To select studies that meet the inclusion and exclusion criteria.

#### Final Inclusion

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All included articles are related to the topic and meet the standards of the Practical Research Center of Kabul University of Medical Sciences.

#### Inclusion criteria

1. Articles published in the period 2000-2022.
2. Articles match with the variables of goal

#### Exclusion criteria

1. Articles on the treatment and prevention of peri-implantitis.
2. Not related with the variables.

#### Variables:

Cigarette: Daily cigarette consumption and its relationship with peri-implantitis.

Periodontitis: History of periodontitis and its effect on peri-implantitis.

Excess cement: The amount of cement that is implanted during the installation of the caravan. And the accuracy of its installation.

Surface topography of the implant: the degree of smoothness and roughness of the surface of the implant and its relationship with peri-implantitis

Inadequate hygiene: Hygiene and cleanliness around the impulse

#### Ethical Considerations

Since the study was not interventional, therefore it is devoid of ethical considerations.

#### Limitation

Some articles are not available for free.

#### Results

Claudio Marcanito and his colleagues concluded in the study that peri-implantitis is not a rare complication and that the prevalence of this inflammatory condition is about 4.7% in 74% of implants and more than 8.9% in 55% of implants, and that it depends on the parameters that determine periimplantitis. High levels of peri-implantitis have been seen more often in patients with periodontal disease, in and in people who smoke.<sup>41</sup>

n their 2020 research, Ciona Nobert and Hashimi Dena found that peri-implantitis is a widespread and complicated condition influenced by multiple factors. Major contributors include periodontal disease, smoking, elevated blood sugar, and obesity. Additionally, local issues such as mucosal inflammation, leftover cement, and poorly designed prosthetics also contribute to the development of peri-implantitis.<sup>42</sup>

Stacchi Claudio and colleagues concluded that based on a systematic study conducted to evaluate the role of smoking and periodontal disease as a risk factor for implant loss and the development of peri-implantitis, they concluded that: There is little evidence that periodontal disease can be a risk factor for the development of peri-implantitis.<sup>43</sup>

In their systematic review and meta-analysis, Mazel Anthony and his team demonstrated that peri-implantitis arises from multiple factors. Typically, it involves loss of bone around the implant margin and is commonly accompanied by symptoms like heavy plaque buildup, bleeding upon probing, and challenges in maintaining oral hygiene. This condition tends to occur more frequently in individuals with a history of periodontitis.<sup>44</sup>

In a 2019 study, Joerg Meyle and his team found sufficient evidence that several overall risk factors impact both the immediate and lasting outcomes of implant therapy. Notably, smoking has a strong effect on periodontal health and the long-term durability of implants. As a result, thoroughly assessing a patient's medical history is essential prior to treatment.<sup>45</sup>

Patients who have previously experienced periodontal disease need to be made aware of their higher risk for peri-implant complications. If periodontitis exists, effectively managing it is crucial to eliminate local issues and restore periodontal health before proceeding with implant placement. If treatment is unsuccessful, implant placement should be postponed or avoided altogether.

Patients who smoke should be offered support to quit smoking, and those struggling with alcohol addiction should receive comparable treatment, as these measures can help enhance the long-term outcomes of implant therapy. Regular follow-up appointments are also important to monitor and catch any early signs of periodontal changes.<sup>46</sup>

In 2016, Claudio Stacchi and colleagues carried out a systematic study to examine if previous periodontitis and smoking habits could contribute to implant failure and peri-implantitis. Their findings indicated that a history of periodontitis is not a significant risk factor for implant loss. Additionally, the study was unable to establish clear conclusions regarding the impact of smoking on supporting tissues and implant failure.<sup>43</sup>

In a 2005 North American study led by Bjorn Klinge and his team, it was observed that patients losing teeth due to periodontal disease face a greater chance of implant failure. The study also noted that cigarette smokers have a higher likelihood of developing pre-implantitis compared to non-smokers.<sup>46</sup>

In a 2020 study conducted by Dina Hashimi and Nobert Ciona, they concluded periodontal diseases, lack of basic supportive cigarette smoking, and hyperglycemia are among the important risk factors for peri-implantitis. Poor plaque control, mucosal inflammation, poorly designed Crohn's implant, and submucosal cement are among the local risk factors for peri-implantitis.<sup>42</sup>

Another study conducted by Frank Schwarz in Germany in 2017 found that the risk of peri-implantitis increases in patients with a history of chronic periodontitis, poor plaque control skills, and irregular post-implant maintenance care. They also stated that diabetes and cigarettes are potential risk factors. And peri-implantitis is associated with factors such as excess submucosal cement, lack of keratinized mucosa around the implant.<sup>29</sup>

Another study conducted by Joerg Myle in Germany in 2015 stated that smoking is one of the important risk factors for peri-implantitis and implant loss.<sup>45</sup>

In a 2015 study conducted by Claudio Stacchi, they concluded that the risk of peri-implantitis was significantly higher in patients with a history of periodontitis compared to healthy people. and stated that periodontitis is a possible risk factor for peri-implantitis. However, there is not enough information about cigarettes in studies.<sup>43</sup>

Claudio Marcanito carried out research in Brazil indicating that various risk factors can contribute to the onset and worsening of peri-implantitis. The study provided solid evidence that having a history of periodontitis may increase the risk for peri-implantitis. Although smoking has not been confirmed as a definitive risk factor, extra caution is advised when managing implants in smokers. Additionally, factors like diabetes, genetic

traits, and the presence of keratinized mucosa require more detailed research and evaluation.<sup>41</sup>

Excess cement is a possible risk indicator for peri-implant diseases and is more frequently with soft tissue healing periods shorter than 4 weeks.<sup>47</sup>

Pre-clinical animal studies suggest that changes to implant surface properties might worsen the progression of peri-implantitis. However, clinical research has not found clear evidence that different implant surface types affect how often peri-implantitis occurs.<sup>48</sup>

High doses of bisphosphonates, hormone therapy and the presence of titanium particles are among the systemic factors for peri-implantitis.<sup>29</sup>

## Discussion

Peri-implantitis is one of the most common condition around the dental implant, and in this review we want to investigate its risk factors.

The literature emphasizes that the type and quality of soft tissue around dental implants plays a key role.

A systematic review that published in 2016 which aimed to find if periodontitis history and smoking may act as predisposing factor for implant failure and developing of peri-implantitis. at the end they emphasizes that history of periodontal disease and smoking affect negatively in progression of peri-implantitis.<sup>18</sup>

Some other reviews show that past periodontal disease is a predictive indicator for peri-implantitis also they point out that bone resorption and deep pockets by themselves are not sufficient to confirm diagnosis of peri-implantitis. Many non infectious factors like surgical methods, design of implant, implant insertion, thickness of surrounding bone and excessive bite forces may cause bone loss.

A systematic review found insufficient evidence to support the concept that a history of periodontal disease increases the risk of peri-implantitis.<sup>3</sup>

There was significant increase(20%) of marginal bone loss around implant with history of smoking and periodontitis compared to nonsmoker with tooth loss due to other causes. As a result this study showed that increasing severity of peri-implantitis in patient with history of smoking and periodontitis and presence of both factor did not increase the severity of disease compared to either of them.<sup>35</sup>

This study suggests that it needs combine analysis to find effect of smoking and periodontitis as potential risk factors. Insufficient oral care<sup>40</sup> and excess cement<sup>26</sup> are a significant risk factor for peri-implantitis. The other main factor for peri-implantitis is accumulation of plaque.

Residual cement have negative affect in maintenance of oral hygiene that cause inflammation and infection of tissue around implant.<sup>15</sup> Nonetheless, these conclusions should be approached carefully due to certain limitations in the data.

Rough surface of implant is more to prone for peri-implantitis as they are plaque retentive and promote colonization of bacteria.

Among the above studies we have reviewed, the higher range of studies highlighted that a history of peri-implantitis, smoking, and neglect of regular maintenance, rough implant surfaces, and excess cement are the most prevalent factors contributing to peri-implantitis.

## Conclusion

Based on the current review article, peri-implantitis is common, complex, and multifactorial disease. Its known risk factors include periodontal disease, lack of maintenance, cigarette smoking, hypoglycemia, inadequate plaque control, mucositis, rough implant surface, excess cement, high doses of bisphosphonates, hormone therapy and the presence of titanium particles.

The most common etiological factors are history of periodontal disease, smoking, lack of maintenance and oral hygiene, rough surface of implant and excess cement around implant abutment.

## Suggestions:

- 1-The further studies should conduct in form of systematic review and meta-analysis.
- 2 – Patients should try to choose a doctor who has higher knowledge and more experience in the field of dental implants

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