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Review Article

Peri-Implantitis: A Comprehensive Overview for the General Dental Practitioner

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Abstract

Considering the significant role of implants in contemporary dentistry, practitioners must be able to acknowledge and anticipate the clinical signs and the appropriate treatment measures of peri-implant disease. The article aims to provide an overview of peri-implantitis, outlining its prevalence, etiology, risk factors, diagnosis, and management for the general practitioner. Peri-implantitis is a pathological condition usually associated with plaque. It exhibits inflammation around the peri-implant mucosa and subsequent progressive bone loss. While some patients show clinical signs, most implants exhibiting peri-implant disease are asymptomatic. As a result, clinicians must first develop an accurate diagnosis based on clinical and radiographic findings. The diagnosis of peri-implantitis usually done if the following criteria are met: 1) presence of bleeding, 2) progressive bone loss, and 3) increased probing depths. It is widely accepted that peri-implantitis is difficult to manage and prevention is the best form of treatment. Early diagnosis and management are essential to the successful clinical outcomes in the treatment of peri-implantitis. While non-surgical treatment may not always be effective but should always come first in patients with advanced peri-implantitis. Good oral hygiene, the location of the damaged implant, and the configuration of the bone defect, appear to be the key factors that influence the clinical predictability surgical interventions.

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Abbreviations: EIF: Early implant failure | IL: Interleukin | TNF: Tumor necrosis factor | PCIF: Peri-implant crevicular fluid | OFP: Open Flap Debridement | Nd: YAG: Neodymium: yttrium aluminum garnet | PINH: Peri-implant non-specific inflammatory hyperplasia | SCC: Squamous cell carcinoma | Er: YAG: Erbium: Yttrium- Aluminum Garnet | GBR: Guided bone regeneration.

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Introduction

Advancements in the field of implantology have made dental implants a predictable treatment for both partially and fully edentulous patients [1]. In fact, studies have reported 92.8-97.1% implant survival rates over a 10-year follow up period [2]. Despite these developments, biological complications persist and pose various clinical challenges. From a clinical standpoint, differentiating between late and early implant failure (EIF) is clinically important. Early implant failure is a failure of the host tissue to osseointegrate prior to abutment connection. On the other hand, late implant failure refers to bone loss in a successfully integrated implant after prosthetic loading [3]. Furthermore, it is important to understand that even though they share similar features, peri-implantitis is not the same as chronic periodontitis. There are clear differences between periodontitis and peri-implantitis on a histopathological level [4]. According to the World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, peri- implantitis is a plaque associated pathological condition occurring in tissues around dental implants, characterized by inflammation in the peri-implant mucosa and subsequent progressive loss of supporting bone [5].

Peri-implantitis is pathological condition associated with a foreign material, and thus, has greater potential for progression and is comparatively a more localized inflammatory process than periodontitis. The disease progresses at a faster rate than periodontitis in a non-linear fashion [4]. Prior to the workshop in 2018, there was no international consensus regarding the definition and diagnosis of peri-implantitis. In fact, there are still a lot of misconceptions in the literature regarding how this condition can be effectively diagnosed and managed. Considering the significant role of implants in contemporary dentistry, practitioners must be able to acknowledge and anticipate the clinical signs and the appropriate treatment measures of peri-implant disease. Given this background, the article summarizes an overview of peri-implantitis, outlining its prevalence, etiology, risk factors, diagnosis, and management for the general practitioner.

Materials and methods

The search strategy located articles, written in the English language, from the databases: Google Scholar, Cochrane library, PubMed and Embase. This review considered analytical observational and experimental studies including systematic reviews, case-control, cross-sectional studies, retrospective cohort, randomized controlled trials and prospective. Animal studies, commentaries, Critical systematic reviews editorials and poster presentations were excluded.

Results and discussion

Prevalence of Peri-implantitis

There is extensive literature on the Peri-implant. However, there is a large degree of heterogeneity with how each study defined, and ultimately diagnosed the disease process. In fact, a review examining 11 studies in 2015 found 1-47% prevalence of peri-implantitis [6]. That notwithstanding, recent studies show that an estimated 20% of dental implant restorations are affected by peri-implant diseases [7].

Etiology and risk factors

The peri-implantitis etiology still remains controversial and is a topic of debate among

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various practitioners. A majority consensus believes the etiology to be multi-factorial. Studies demonstrate an inflammatory response can be triggered due to the plaque accumulation around dental implants, leading to peri-implant mucositis, which if left untreated, can results in peri-implantitis [8-10]. A study examining protein levels in peri-implant crevicular fluid (PCIF) found higher levels of proinflammatory cytokines (IL-17, TNF-α, IL-6 and IL-1β) in implants with peri-implantitis than in healthy implants [9]. In patients with peri-implantitis, the increased levels of IL-1β and TNF-α in PCIF were linked to clinical findings such as increased bleeding on probing, probing depths, and bone loss [10]. Given this background, external factors that may exacerbate the inflammatory response become potential risk factors in the progression of peri-implant disease. Of note, A history of periodontal disease constitute and unhygienic restorations resulting in bacterial plaque accumulation are two contributing risk factors for peri-implantitis [4,11-16]. A summary of potential risk factors is summarized in Table 1.

Risk factor	Literature review
Plaque accumulation	• plaque accumulation and lack of maintenance therapy constitute risk factors for the development of peri-implantitis [4] • Poorly designed/contoured implant prosthesis can obstruct access for oral hygiene and lead to biofilm accumulation [12] • Higher incidence of peri-implantitis in implants with a lack of accessibility (48%) vs. implants that allowed for adequate cleansibility (4%) [13] • anti-infective treatment strategies are successful in decreasing soft tissue inflammation and suppressing disease progression [14]
Periodontal Disease	• strong evidence indicating that a history of periodontitis is a risk factor for peri-implantitis [4] • Significantly lower incidence of peri-implantitis was found in patients without a history of periodontitis [2] • Higher incidence of peri-implantitis was reported in patients with a history of aggressive periodontitis (26%) vs. non- periodontitis patients (10%) [15]
Smoking	• At the present time, there is no conclusive evidence which constitutes smoking as an established risk factor for peri- implantitis [17] • Smoking can modify the core microbiome of the peri implant habitat-negative effects on the subgingival microbiome, supporting the formation of pathogen-rich communities [18,19]
Diabetes	Available evidence is inconclusive as to whether diabetes is a risk factor for peri-implantitis [4]
Excess Cement	Excess dental cement is associated with clinical and/or radiographic signs of peri-implant disease [20]
Local Hard/ Soft Tissue Deficiencies	• A systematic review on the causes of major implant complications found [21]: • Implant too buccally positioned=40.5%, Soft tissue biotype=21.5%, Inadequate keratinized tissue=29%, Other factors=9% • Buccal wall thickness of less than 2mm following implant placement is more prone to resorption [22] • A lack of keratinized mucosa around implants is associated with increased plaque accumulation, inflammation, mucosal recession, and attachment loss [23]

Table 1: Potential Risk Factors for Peri-Implantitis.

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Diagnosis of Peri-implantitis

Erythema, pain, swelling, suppuration, bleeding on probing is common clinical symptoms of peri-implant disease [4]. Interestingly, it has been shown that up to 90% of implants exhibiting peri-implant disease elicit no symptoms to patients [24]. The asymptomatic nature of this condition may contribute to a lack of awareness among patients of insidious disease progression and prevent them from seeking care. Given this background, practitioners must first develop an accurate differential diagnosis (summarized in Table 2) and rely on standardized clinical guidelines to determine the correct diagnosis.

Firstly, it is essential for the practitioner to differentiate between healthy implant and peri-implant disease before for making an appropriate diagnosis.

Differential Diagnosis
1. Physiologic bone loss
2. Biomechanical problems: Implant fracture
3. Oral-mucosal lesions mimicking peri-implantitis [25,26]
A. Benign
i. Non-specific inflammatory hyperplasia (PINIH)
ii. Pyogenic granuloma
iii. Peripheral giant cell granuloma
B. Secondary or primary malignancy [27]
i. Squamous cell carcinoma (SCC)
ii. Metastases

Table 2: Conditions with similar clinical presentations as Peri-implantitis.

Peri-implant health is characterized by the absence of inflammation, bone loss, and bleeding/suppuration upon probing. Furthermore, there should be no increase in probing depths at each subsequent visit [5].

In contrast, peri-implant disease can manifest in one of two ways: peri-implantitis or peri-implant mucositis [4]. From a clinical standpoint, peri-implantitis is preceded by peri-implant mucositis if treated appropriately. Presence of bleeding, with or without increased probing depths, and progressive bone loss are used as diagnosis measures. On the other hand, peri-implantitis is not always fully reversible and can only be diagnosed if the following criteria are met: 1) progressive bone loss, 2) presence of bleeding, and 3) increased probing depths.

Management

While the distinction between peri-implantitis and peri-implant mucositis can be made clinically, determining disease severity and treatment prognosis remains a challenging proposition for many general practitioners. According to the literature, a non-salvageable implanted device presenting with significant bone loss and mobility is called as a failed implant [28,29].

However, an ailing implant is a primarily restored, osseointegrated prosthesis exhibiting clinical, radiographic, and microbiological patterns of peri-implant disease [30]. Prior to initiating treatment, it is important to conduct a thorough assessment of the implant site and decide whether the implant is salvageable. Clinical findings suggestive of a poor/hopeless

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prognosis include probing depths >8mm, inadequate seating of final restoration, radiographic bone loss >50%, and severe mobility [29]. Ultimately, the decision to save or replace an ailing implant should be made based on individual patient factors, including a patient's financial limitations and psychological attachment. When it comes to the treatment, it is important to understand that peri-implantitis cannot be cured but only be managed; therefore, prevention is the best form of treatment. Since peri-implantitis is preceded by peri-implant mucositis (and is reversible if treated appropriately), early detection and treatment is essential for the successful clinical outcomes. The treatment modalities for peri-implantitis (Figure 1) can be broadly categorized under two headings: non-surgical therapy and surgical therapy.

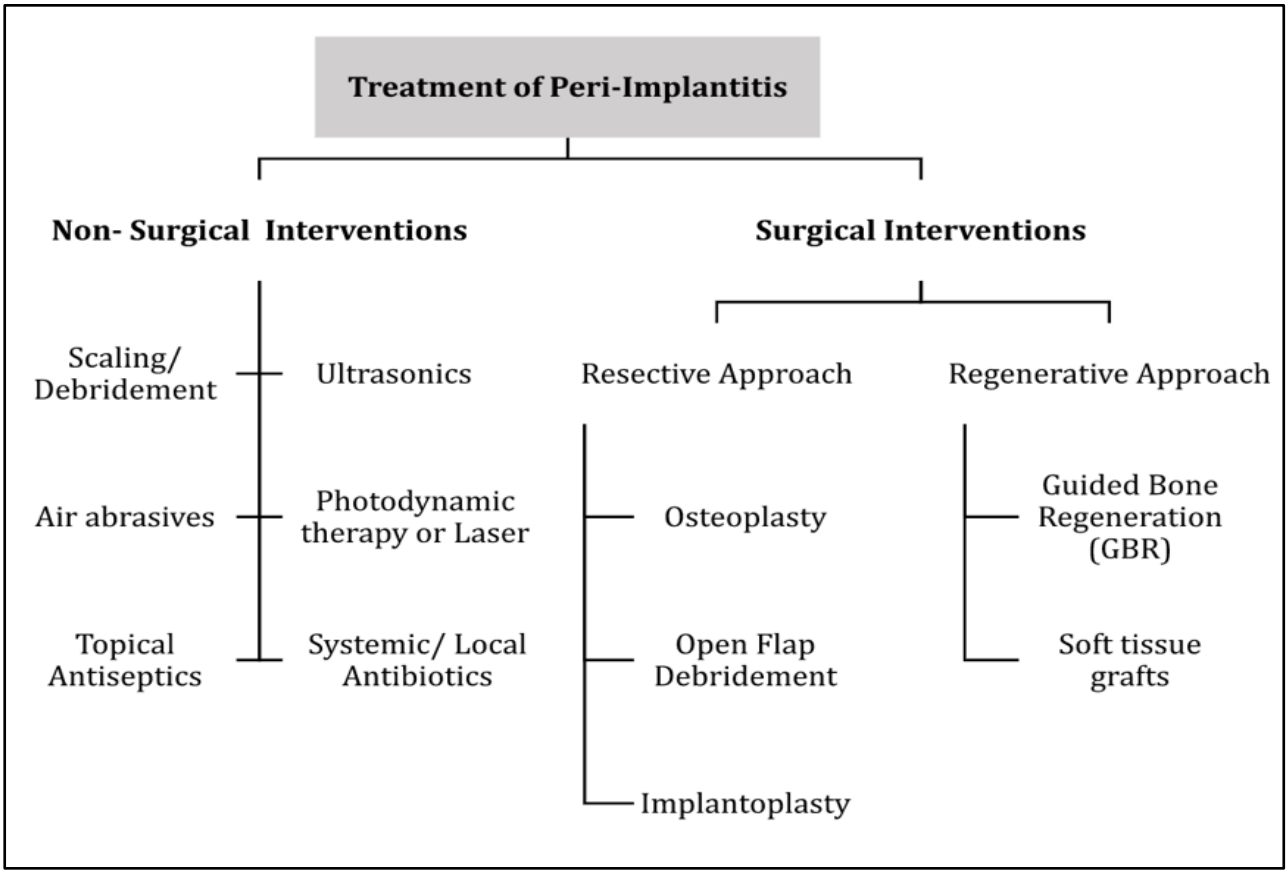

Figure 1: Overview of therapeutical Approaches in Peri-Implantitis.

Non-surgical therapy

Considering the severity of the peri-implant lesion, non- surgical therapy in conjunction with patient compliance has demonstrated improved clinical outcomes in the literature [31,32,21]. While non-surgical therapy may not always be successful in advanced cases, it should be considered to be administered first before any surgical intervention [33]. The intention behind this approach is to give clinician more time to study the disease progression, tissue healing and/or regression of inflammatory process. Table 3 provides an overview of commonly used non-surgical interventions for peri-implantitis management.

Surgical therapy

The challenges associated with peri-implantitis treatment are largely due to the

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rough implant surface structure, and presence of threads, making it difficult to decontaminate even during surgical procedures.

Intervention	Literature Findings
Scalers/mechanical Debridement	• "Gold standard "of non-surgical treatment modality • Metallic tips and ultrasonic scalers remove bacteria efficiently, but are technique-sensitive and can damage implant surfaces [34,35] • Plastic scalers or Teflon coated curettes reduce the risk of implant surface damage but are technique sensitive and less effective in bacterial decontamination [36]
Local Antiseptics	• Adjunctive use of chlorohexidine gel did not improve clinical outcomes when compared to mechanical debridement alone [37] • Use of citric acid and hypochlorite is not recommended as they could alter the implant surface quality, and lead to localized toxicity [38]
Antibiotics (Local and Systemic)	• Minocycline microspheres and tetracycline fibers: Local administration of antibiotics in conjunction with mechanical debridement has demonstrated positive clinical and microbiological parameters [39] • Adjunctive use of systemic antibiotics with mechanical debridement does not improve clinical outcomes [40]
Lasers	• Clinical applications can decrease bacterial load surrounding the implant and allow for better post-operative recovery [41] • CO_2, Er; YAG, and Nd: YAG laser are the most commonly used [42] • Er: YAG lasers are recommended as it does not negatively impact the implant, nor does it overheat the surrounding tissue. The efficacy is limited to 6 months in treating advanced cases of peri-implantitis [42,43]

Table 3: Non-surgical Interventions in the management of Peri-Implantitis.

Thus, the primary goal of surgical intervention is to improve access and visibility [42]. Ultimately, clinical outcomes of surgical interventions are contingent on the location of the damaged implant, configuration of the bone defect, and the patient's capacity to maintain adequate oral hygiene. Surgical interventions for peri-implantitis can be categorized as either non-augmentative or augmentative. The non-augmentative approach includes open flap debridement (OFP), aimed at decreasing inflammation and bone loss [43], as well as other resective therapeutical approaches which look to eliminate the recontour bone, peri-implant pocket, and apically position the mucosal flap [44]. In certain clinical situations, practitioners may also utilize an augmentative approach to management. The treatments in this category aim to limit recession of soft tissue, regenerate bone, and promote re-osseointegration [45]. A summary of surgical interventions and indications can be found in Table 4. From a clinical standpoint, surgical regenerative treatment can be effective as viable treatment option for intrabony defects following successful implant surface decontamination and pre- and postsurgical hygiene maintenance phases. It should be highlighted; however, no scientific evidence is present to claim that regeneration treatments including the use of bone grafts. Moreover, membranes result in better treatment outcomes than nonregenerative procedures.

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Non- Augmentative Approach Indications [46.48]: Horizontal bone loss with exposed implant threads Non- esthetic areas	
Intervention	**Literature Findings**
Open Flap Debridement (OFP)	• Mechanical debridement of implant surfaces by lifting a flap for direct access • Mechanical strategies alone are insufficient for adequate surface decontamination [52] • Surface decontaminants include saline, citric acid, 3% H_2O_2, iodine solutions 24%, CHX 0.2%, EDTA, tetracycline- The method of implant surface decontamination or material used does not impact clinical or microbiological outcomes [47,52]
Resective Therapy	• Implantoplasty- the removal and polishing of implant surfaces to decrease plaque adherence • Improved implant survival rates, decreased pocket depths, and effective in reducing peri-implantitis progression [50,52] • Implantoplasty can be effective when done in combination with osteoplasty, ostectomy, and apical flap repositioning [50] • Narrow and internal connection implants may not be suitable for this approach as they carry an increased risk of fracture [52]
Augmentative Approach Indications [49]: **Intrabony defects with presence of keratinized tissue** **Motivated non-smoking patient**	
Intervention	**Literature Findings**
Guided Bone Regeneration (GBR)	• Utilization of bone graft materials, with or without autogenous bone, or barrier membranes for bone regeneration of peri-implant bone defects • It remains unclear whether the addition of biologic agents such as platelet- rich fibrin (PRF) or bone morphogenic proteins (BMP) can promote defect regeneration [51]

Table 4: Surgical Interventions in the management of Peri-implantitis.

Thus, Regenerative surgery is the preferred method when dealing with a well-contained osseous defect. Conversely, resective surgery is a more predictable course of action for treating peri-implantitis when the morphology of a bony defect will not contain a bone graft material [53].

With the insufficient soft tissue dimensions, at implant locations, to support the peri-implant soft tissue health or marginal bone levels, the use of autogenous soft tissue grafting can also be considered by the clinicians. In the presence of keratinized tissue (>2mm), adequate plaque control is better facilitated. A free gingival graft should be considered if more keratinized tissue is needed surrounding the dental implant. Additionally, clinicians should think about improving the stability of interproximal marginal bone levels using connective tissue grafting techniques [54].

Conclusion

Peri-implantitis is a pathological condition usually associated with plaque. It exhibits inflammation around the peri-implant mucosa and subsequent progressive bone loss. Since many patients do not exhibit symptoms, it is essential that clinicians first develop an accurate differential diagnosis based on the radiographic and clinical findings. Ultimately, a correct and definitive diagnosis of peri-implantitis is required. Since peri-implantitis is precede by peri-implant mucositis and is reversible even

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after appropriate treatment, early diagnosis is essential to successful clinical results. There is currently no definitive protocol for the treatment of peri-implantitis recognized as the gold standard. Implant infection should be centered around the detoxification of the implant surface, regeneration of the alveolar bone and control of post-implant infection.

In conclusion, peri-implantitis treatment consists of a nonsurgical phase that uses mechanical, laser debridement or ultrasonic, alone or in combination with antibiotic drugs or antiseptic and a surgical phase that makes use of either reconstructive or regenerative procedures. If the implant cannot be preserved due to advanced bone loss, it must be removed.

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