International Journal Dental and Medical Sciences Research
Volume 4, Issue 5, Sep-Oct 2022 pp 485-493 www.ijdmsrjournal.com ISSN: 2582-6018

Management Matrices of Peri-Implantitis –A Contemporary Overview A Review Article

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Submitted: 15-10-2022 Accepted: 31-10-2022

ABSTRACT
The past 3 decades have witnessed a gradual integration of implant dentistry into modern dentistry. With the increase in the number of dental implants being used, there is a commensurate increase in the biological, mechanical and clinical complications leading to peri-implant diseases. Early detection and treatment of mucositis and peri-implant bone loss along with good patient compliance are the keys to long-term clinical and functional success ofimplant -supported restorations.
Key words-Dental Implants, Peri-implantitis, Periodontal bone loss

I. INTRODUCTION

Dental implants play a pivotal role in the rehabilitation of missing teeth and have been seamlessly integrated in contemporary dental practice. However, biological, mechanical and clinical complications lead to peri-implant diseases with a substantial global economic burden.

Natural teeth versus Dental Implants

Clinical and histological studies have documented the analogy and disparity between the natural dentition and dental implants. [1] The dental implants lack the well -structured anatomy and histology of a natural tooth; with absence of characteristic structures such as root cementum, periodontal ligament, and bundle bone (alveolar bone proper) [2], and with parallel orientation of collagen fibers on the implant surface vis -a -vis the perpendicular insertion of collagen on in the cementum of natural teeth. (Figure 1) The reduced cellularity and poor vascularity on the implant surfaces makes them more amenable to initiation and progression of peri-implant diseases.

Figure 1: - Natural Tooth Versus Dental Implant

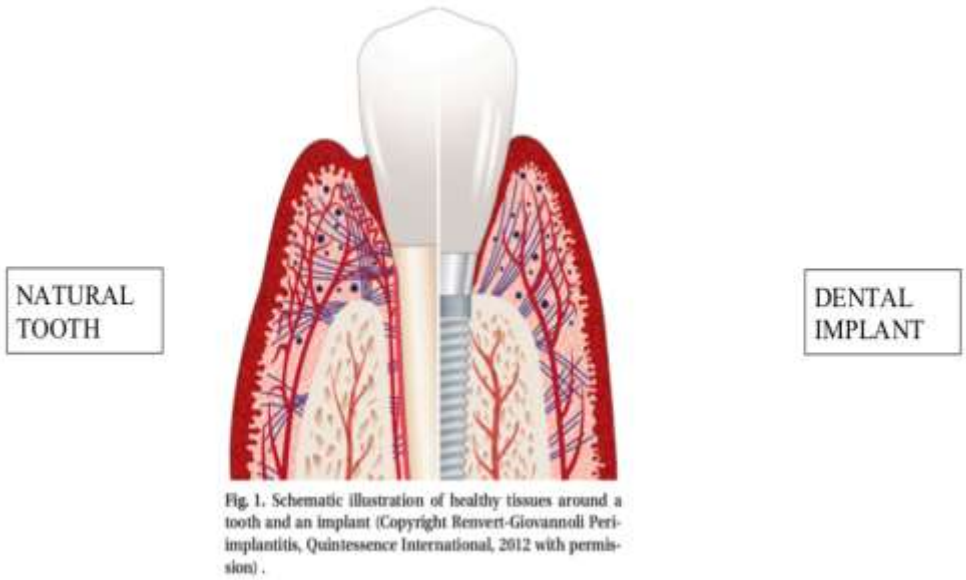

Fig. 1. Schematic illustration of healthy tissues around a tooth and an implant (Copyright Renvert-Giovannoli Peri-implantitis, Quintessence International, 2012 with permission) .

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Periodontitis Versus Peri-Implantitis (Figure 2)

Periodontitis and peri-implant diseases are similar with respect to the aetiology, pathogenesis, and risk factors; the dental biofilm play a pivotal role in aetiology of both of them. (Figure 2) However, unlike periodontitis, progression of the peri-implantitis lesion is much faster, more apically spread, and has a more unpredictable response to both surgical and nonsurgical treatment. [3-6]

(Figure 2) **Periodontitis Versus Peri-Implantitis**

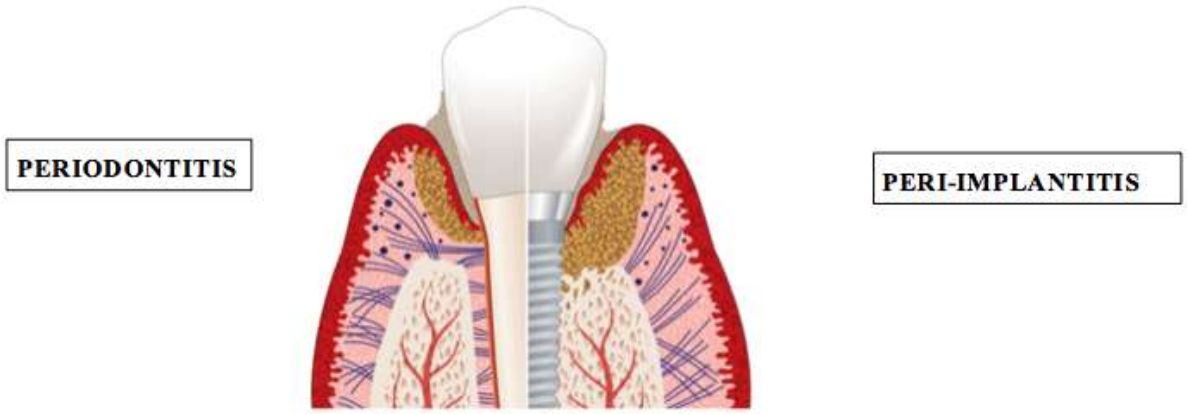

Fig. 2. Schematic illustration of a lesion at a tooth and an implant (Copyright Renvert-Giovannoli Peri-implantitis, Quintessence International, 2012 with permission).

The Changed Vector Of Case Definitions Of Peri-Implant Diseases

Mombelli (1987)[6]: -Described peri-implantitis as a disease entity with many features similar to periodontitis.

1st European Workshop on Periodontology (EWP) 1993: - First defined peri-implant diseases, including peri-implant mucositis and peri-implantitis; they officially accepted the terminology "peri-implantitis". [7]

The 6th EWP (2008)- Introduced the term "peri-implant disease" for both peri-implant mucositis and perimplantitis and considered the disease entity as treatable. [5]

The 7th EWP (2011): - Revised the case definitions of peri-implantitis and re-iterated the importance of changes in the crestal bone levels presence of bleeding on probing (BOP)/or suppuration, with or without concomitant deepening of peri-implant pockets. [8]

The 8th EWP (2012): Defined "peri-implantitis" as an inflammatory reaction associated with the loss of supporting bone beyond the initial biological bone remodeling around an implant in function. [3]The American Academy of Periodontology (AAP) in 2013: -Same definitions as the 8th EWP [9] 11th EWP, (2017) World Workshop on the Classification of Periodontal and Peri- Implant Diseases and Conditions [10 11]Diagnosis of peri-implant mucositis is based on the criteria of the presence of peri-implant signs of inflammation (redness, swelling, or bleeding line or drop, within 30 seconds after probing), an increase in probing depths compared to baseline,with no additional bone loss following the initial healing.Peri-implantitis can be diagnosed clinically based on the criteria of peri-implant signs of inflammation with radiographic evidence of bone loss following initial healing and an increased probing depth (PD) compared with the PD after the placement of the prosthetic reconstruction. In the absence of the previous radiographs, a radiographic bone level ≥3 mm accompanied with bleeding on probing (BOP) and PD ≥6 mm is indicative of peri-implantitis.

The Journey Of Peri-Implant Mucosa To Peri-Implant Mucositis

Bacterial biofilm around osseointegrated dental implants play a key role in the aetiology of peri-implant mucositis with a cause and effect relationship between them. [12] Peri-implant mucositis is analogous to gingivitis in its presentation and reversible in nature. [11] However, experimental peri-implant mucositis may take longer than 3 weeks for clinical reversibility unlike gingivitis, which is reversible (21 days) after implementation of plaque control measures. Human studies have shown larger inflammatory lesions at short-term (3-week) recall in peri-implant mucositis as compared to gingivitis. [11-13]

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Volume 4, Issue 5, Sep-Oct 2022 pp 485-493 www.ijdmsrjournal.com ISSN: 2582-6018

The Journey from Peri-Implant Mucositis To Peri-Implantitis

Longitudinal studies by Costa et al (2012) on patients with peri-implant mucositis had concluded that those patients who were non-compliant in their supportive peri-implant therapy had an increased risk of transitioning into peri-implantitis. [14]Risk factors and parameters for diagnosis of peri-mucositis and peri-implantitis are briefly summarized in Figure 3& 4 respectively. [16,17]

Figure 3- **Risk Factors And Indicators Of Peri-Implant Mucositis**

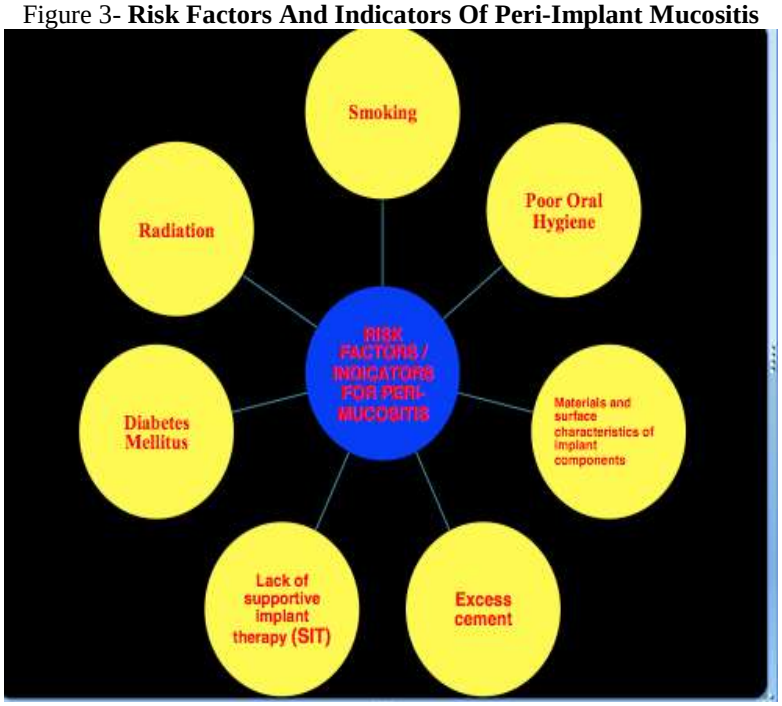
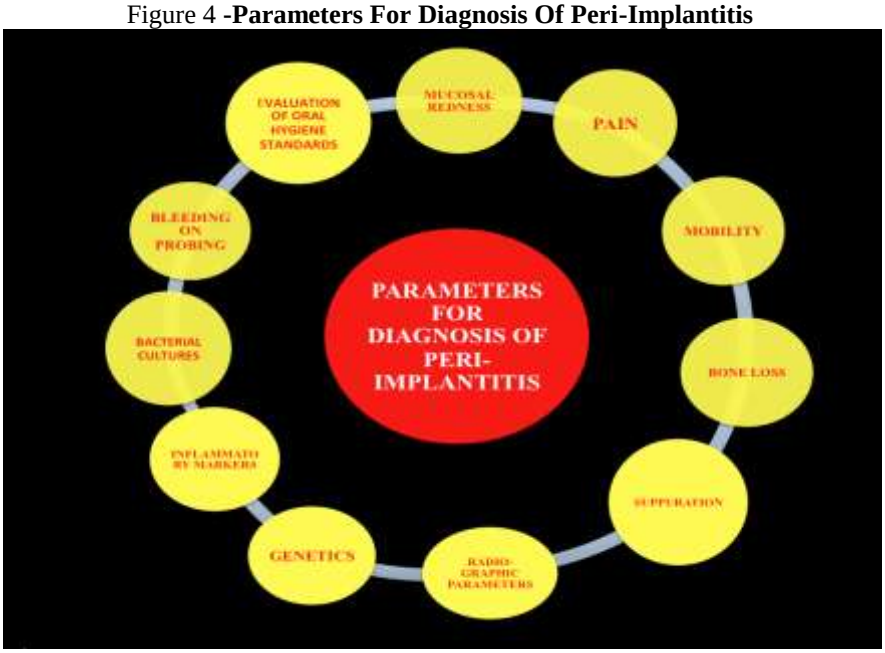


Figure 4 -**Parameters For Diagnosis Of Peri-Implantitis**



Clinical Implications Of The Parameters Of Peri-Implant Diseases

1**.Peri-Implant Probing Depth (PPD)**

Studies have shown that PPD around implants could vary based on the implant-neck design. [18,19] An animal study also revealed that the

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Volume 4, Issue 5, Sep-Oct 2022 pp 485-493 www.ijdmsrjournal.com ISSN: 2582-6018

healthy tissue-level implants had similar biologic width to natural teeth in contrast with bone level implants. [20] PPD around implants is also influenced by the duration of time that the implant has been in function; there is a 0.22mm increase in PPD with each year in function of the implant. [21]

2.Bleeding on probing (BOP)

In detection of periodontitis, bleeding on probing has a high specificity and sensitivity [22-25]; however, this parameter may not have high specificity in healthy peri-implant tissues due to a weak desmosomal attachment and the mucogingival shift after implant placement. [25] Based on several studies it was concluded that BOP is not a reliable marker for detection of perimplantitis when used alone.[28]

3.Suppuration

Suppuration is a reflection of an inflammatory process in the tissues and hence is a highly specific clinical parameter of progressive forms of periodontitis and peri-implant inflammation. In-peri-implant mucositis,it has low predictability rate,conversely ,it has a high predictability in peri-implantitis.Hence suppuration is an important clinical endpoint to disclose progressive peri-implant bone loss [28,29]

4.Mucosal Redness (MR)

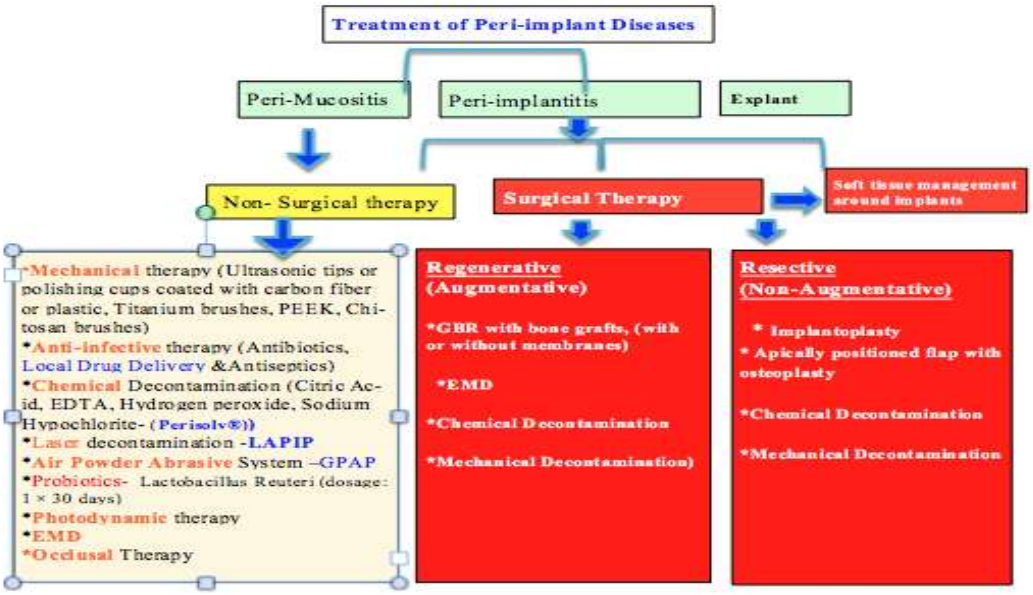
Plaque accumulation and mucosal redness have a cause-effect relationship with respect to natural teeth [30] and implants. [13] A study by Monje et al in 2018 found that MR is an accurate diagnostic tool to monitor mucositis and peri-implantitis and was usually associated with BOP. [19]

5.Radiographs For Detection Bone Loss

Although the clinical presentation of inflammation in peri-mucositis and peri-implantitis are similar,they distinctly differ in the presence of bone loss, which is evident in the latter on dental radiographs.[31] There is heterogeneity in bone loss thresholds to diagnose peri-implantitis. Some authors had formulated the Implant

Success Index. [32] Froum et al proposed a classification of peri-implantitis based on the percentage of bone loss with respect to the length of the implant. [33] The Sixth, Seventh and Eight EWPs [5,7,34] considered the change in crestal bone levels to baseline data for diagnosis of peri-implantitis. Alveolar bone loss in the first year of function of the implant is mainly attributed to bone remodeling and should not exceed 2 mm. [35,36]; ≥2 mm of alveolar bone loss is suggestive of pathology.

FIGURE 5.**TREATMENT APPROACHES FOR PERI- IMPLANT DISEASES**



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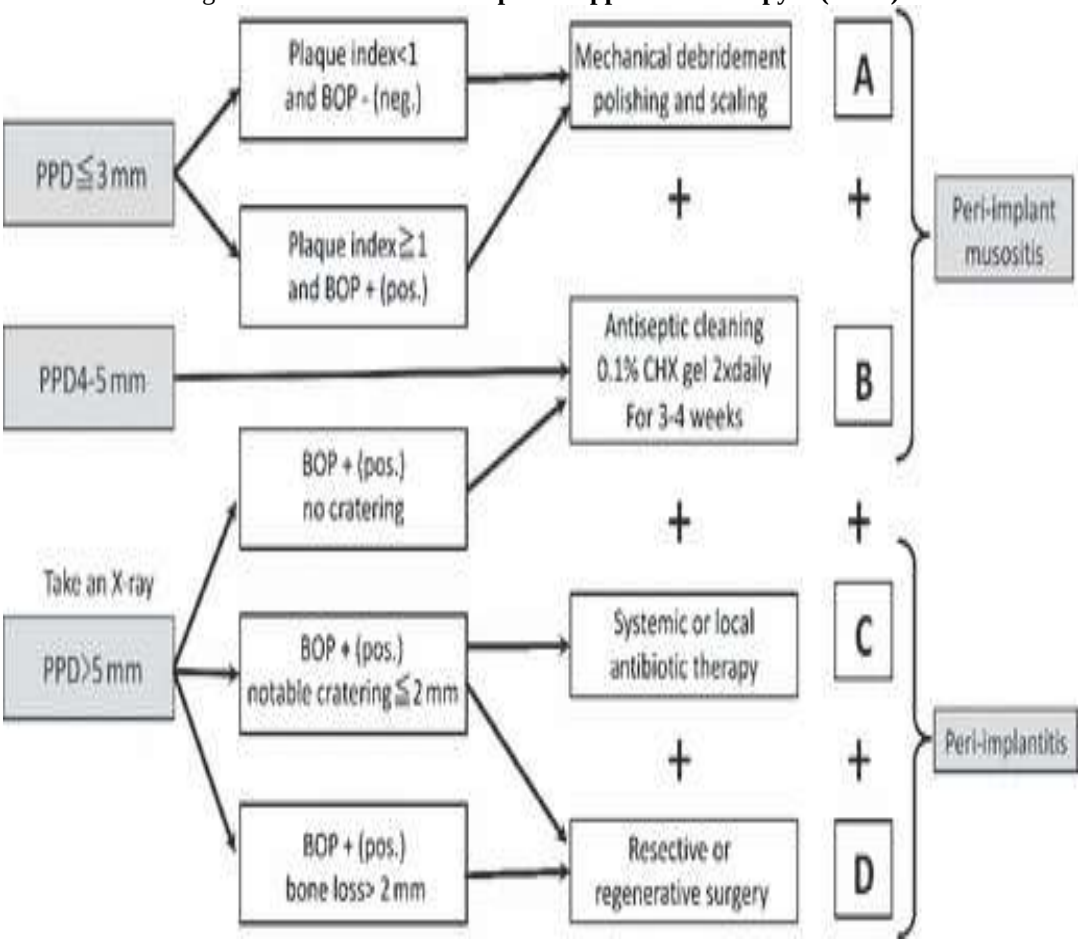
Abbreviations
LAPIP-Laser Assisted Peri-Implantitis Procedure
GPAP-Glycine powder air-polishing
PEEK – Polyetheretherketone
EDTA –Ethylene diamine tetra-acetic acid
EMD-Enamel Matrix Derivatives
GBR-Guided bone regeneration

The current treatment strategies for peri-implant diseases are based on the Cumulative Interceptive Supportive Therapy **(CIST**) Protocol, which was summarized by Lang et al. [4]

Figure 6.**Cumulative Interceptive Supportive Therapy [4] (CIST)**



This CIST protocol includes a sequence of protocols which include non-surgical interventions (A: mechanical debridement, B: antiseptic therapy, C: antibiotic therapy) followed by surgical procedures (D) and Explantation as the last therapeutic step (E). However, the CIST protocol flawed intrinsically due to its dependence on the implant pocket depth, which is varied even in healthy status.

A.PERI-IMPLANT MUCOSITIS THERAPY
Non -Surgical Treatment Modalities

Treatment of peri-implant mucositis therapy generally entails supragingival and sub - gingival mechanical debridement with specially designed hand instruments made of titanium, plastic, Carbon fiber, Polyetheretherketone (PEEK) or Teflon -coated instruments. [37,38]

Studies have also shown that a number of therapies have been used for treatment of peri-mucositis; these include mechanical therapy with or without the adjunctive use of antiseptic rinses [39] administration of antibiotics,the use of glycine powder air polishing (GPAP)or sodium carbonate abrasive air powdering. [40] A systematic review of literature by Renvert et al [41] concluded that non-surgical treatment of peri-implant mucositis was effective and had more pronounced benefits when anti-microbial agents were used as adjuncts to anti-microbial rinses**.**

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Take home message

Non-surgical therapy is effective for treatment of peri-implant mucositis when it is coupled with professional mechanical debridement and home-use oral hygiene techniques, with or without the adjunctive use of antimicrobials.

B.TREATMENT OF PERI-IMPLANTITIS
Non -Surgical Treatment Modalities

1.Mechanical Debridement of Biofilm (Non-surgical therapy)

A meta-analysis of 29 review articles [42]demonstrated that there was a reduction in BOP after non-surgical therapy; however, there was no statistically significant difference in PPD between hand scaling with carbon fiber or titanium curettes when compared with ultrasonic scaling or air polishing.[43]

2.Adjuncts to Mechanical Debridement (Non-surgical therapy)

A narrative review of recent published protocols (2014-2020)[44]for the non-surgical treatment of peri-implant diseases concluded that currently proposed adjunctive methods to non-surgical approaches (including Chlorhexidine, Lasers, Probiotics, Photodynamic therapy etc.) for the treatment of peri-implant diseases, help in reducing clinical signs of peri-implant inflammation. (E.g., BOP) However, it has very limited effect on the surrogate outcome on clinical parameters like probing depth and has a high tendency for recurrence.

Take -home message

The non-surgical protocols pave the way to prepare healthier soft tissue conditions prior to surgery, give time for evaluation of healing response of tissues and help to monitor the patient's ability to maintain oral hygiene.

Surgical therapy for treatment of peri-implantitis

Peri-implantitis is a polymicrobial disease; hence a surgical approach may be required in cases of advanced peri-implantitis when the first line of treatment, the non-surgical one failed with persistence and recurrence of bleeding and suppuration.[45]Surgical procedures for treatment of peri-implantitis include open flap debridement of the implant surface, resective surgery, implantoplasty, and regenerative therapy with bone substitutes and barrier membranes.

Decontamination/Detoxification of the implant surfaces

In order to promote healing, it is mandatory to decontaminate the surfaces, which are exposed to the biofilms. These decontamination procedures could be mechanical, chemical or with lasers. **Mechanical** decontamination and debridement of the exposed implant surfaces can be achieved with the help of curettes, Titanium brushes, ultrasonic devices with special tips and air-powder abrasives; with similar advantages and drawbacks of these systems in non-surgical therapy. [54] However to obtain optimal results, mechanical decontamination should be followed by **chemical** decontamination of the exposed implant surfaces prior to surgery, with the help of hydrogen peroxide (3%), chlorhexidine gluconate (0.2%), citric acid,Iodine solutions (24%)sodium chloride, chloramines, 0.2% EDTA, tetracycline hydrochloride etc.

Take- home message

Regardless of the implant surface, no single method of decontamination has proved to be superior which is primarily due to direct recontamination by the oral flora.[46]

Augmentative (Regenerative) surgical procedures for treatment of peri-implantitis

The osseous defect configuration at surgical site generally dictates the decision and clinical outcome of regenerative surgery. [34] However, mechanical and chemical decontamination of the implant surfaces are mandatory prior to the regenerative procedures. Guided bone regeneration using a wide array of bone grafting materials like autogenous bone, demineralized freeze- dried allogenic bone, bovine inorganic bone and hydroxyapatite, in combination with resorbable or non-resorbable membranes have been used successfully for the treatment of peri-implantitis.Consensus report by Khoury et al [47] and a narrative review by Solderer et al [48]had concluded that favorable clinical and radiographic outcomes were obtained with surgical augmentative therapy for peri-implantitis.

Take -home message

1. Evidence- based literature does not support the superiority of a specific material, product or, membrane in terms of long-term treatment outcome. Membranes should not be used in self-containing defects but only in complex cases. [47,48]
2. Implant surface debridement with air polishing is more effectively delivered than with ultrasonic or hand instrumentation. [49]
3. Although autogenous bone is the gold standard for grafting periodontal defects, however, they may undergo approximately 40% shrinkage during the healing process. Hence a mixture of

xenogenic and autogenous bone is discussed as the most suitable. [19]

Non-augmentative (Resective) surgical procedures for treatment of peri-implantitis

Whenever there is horizontal bone loss /dehiscence and the wide defects are not well-contained or amenable to augmentative procedures, such defects around implants are then ideally treated with non –augmentative procedures like Osteotomy/Osteoplasty, Apically positioned flap with/ without bone re-contouring and implantoplasty.[50] Implantoplasty is another form of surface modification done in conjunction with a resective surgical approach for the treatment of peri-implantitis. It involves the removal of implant threads and smoothening of the implant surface with the help of rotating instruments with adequate coolant after flap reflection during surgery. [48]It is generally advisable to do implantoplasty in the non- aesthetic areas since the exposed implant threads would be undesirable in the aesthetic zone.

To explant or not to explant is the question!

Misch et al (2008)[35] had proposed that ≥75% of bone loss or less than 3 mm of remaining bone contact guides as a critical threshold for implant failures.Different techniques of implant removal include Counter-torque ratchet technique (CTRT), use of trephine burs, laser surgery, piezosurgery, high-speed burs, elevators and forceps.

Solderer et al (2020)[48]had concluded that the CTRT technique alone or combined is generally the first choice for the clinician since it is less invasive.

II. CONCLUSION

The dental team has the onus of correct case selection from a delicate palette of treatment options based on clinical expertise. A rational and evidence-based approach is required for the optimal management and treatment of peri-implantitis. It is important to emphasize that early detection and treatment of mucositis and peri-implant bone loss along with good patient compliance are the keys to long-term clinical and functional success of implant -supported restorations.

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Legends

Figure 1: Natural tooth versus Dental Implants (adapted) Renvert S, Giovannoli JL. Pathogenesis. Chapter 1. In: Renvert S, Giovannoli JL, editors. Peri-Implantitis. France: Quintessence International; 2012. p. 5

Figure 2: Periodontitis Versus Peri-Implantitis(adapted) Renvert S, Giovannoli JL. Pathogenesis. Chapter 1. In: Renvert S, Giovannoli JL, editors. Peri-Implantitis. France: Quintessence International; 2012. p. 8.

Figure -3-Risk factors and indicators of peri-implant mucositis

Figure 4 Parameters For Diagnosis Of Peri-Implantitis

Figure 5-Treatment approaches of Peri-implant Diseases

Figure 6 -Cumulative Interceptive Supportive Therapy. (CIST)