

RESEARCH ARTICLE

PERI-IMPLANTITIS-AN OVERVIEW (PART-1)

1,*Aishwarya Shirude, 2Divya Agarwal, 3Daisy Happy, 4Nihal Devkar and 5Praful Walke

¹PG Student, Sinhgad Dental College and Hospital, Pune, India

²PG Student, Sinhgad Dental College and Hospital, Pune, India

³Reader and Guide, Sinhgad Dental College and Hospital, Pune, India

⁴Professor and Guide, Sinhgad Dental College and Hospital, Pune, India

⁵PG Student, Sinhgad Dental College & Hospital, Pune, India

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ABSTRACT

Peri-implantitis has been defined as an inflammatory condition involving dental implants, surrounding mucosa and bone, which lose supporting bone. Bone, for a variety of reasons, is lost around the dental implant. Most patients are unaware that they have bone loss around the dental implant. Peri-implantitis generally progresses in a painless fashion. The objective of this review is to identify case definitions and clinical criteria of peri-implant healthy tissues, peri-implant mucositis, and peri-implantitis and to introduce a classification system based on added clinical, and detailed radiological parameters with prognosis and staged treatment algorithms and to describe the different approaches to manage both entities. The case definitions were constructed based on a review of the evidence applicable for diagnostic consideration. There is lack of a standard classification system to differentiate the various degrees of peri-implantitis, which produces dilemma in evaluating the stages clinical and radiological status, treatment and its outcome. Many classifications has been proposed in medical literature with their pros and cons but still there is lack of standard classification system of implant defects and definite treatment protocol according to the same. The classification should be easy to use, clearly understandable and help in communication by clinicians of different specialty.

Key words: Peri-Implantitis, Implant, Peri-Implant Mucositis.

INTRODUCTION

Implantology is one of the rapidly growing areas of dentistry which provides an alternative treatment modality for the rehabilitation of edentulous and partially edentulous patients (Xu, 2008). Although there has been great progress in treating patients with implants as an alternative to traditional, tooth supported prosthesis, maintaining healthy peri-implant tissues remains a challenge. There is general agreement that plaque control is essential in preventing peri-implant infections (Hickey, 1991). The inflammatory lesions that develop in the tissues around implants are collectively recognized as peri-implant diseases (Augthun, 1998). Failure of osseointegrated dental implants is a frustrating problem for the patient and dentist. Peri-implantitis and occlusal overload are the most common causes of implant failure after osseointegration, and they often require removal of the involved implant (Klinge, 2005). Hence early diagnosis of peri-implantitis is very important to terminate the further progression of the diseases and for establishment of good osseointegration (Zitzmann, 2008).

Definitions

Peri-Implant Health: Araujo and Lindhe also concluded that peri-implant health requires the absence of clinical signs of inflammation (i.e. erythema and swelling) including no bleeding on probing (Renvert, 2018).

Peri-implant health: Case definitions for day-to-day clinical practice: The diagnosis of periimplant health requires:

- Visual inspection demonstrating the absence of peri-implant signs of inflammation: pink as opposed to red, no swelling as opposed to swollen tissues, firm as opposed to soft tissue consistency;
- Lack of profuse (line or drop) bleeding on probing;
- Probing pocket depths could differ depending on the height of the soft tissue at the implant location. An increase in probing depth over time, however, conflicts with peri-implant health; and
- Absence of further bone loss following initial healing, which should not be ≥ 2 mm (Renvert, 2018).

Peri- Implant Mucositis: The American Academy of Periodontology has defined peri-implant mucositis as a disease that includes inflammation of the soft tissues surrounding a dental implant, without additional bone loss after the initial bone remodeling that may occur during healing following the surgical placement of the implant (Renvert, 2018).

Peri-implant mucositis: Case definitions for day-to-day clinical practice

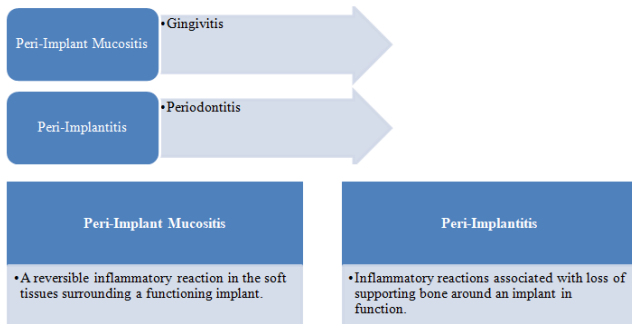
The diagnosis of peri-implant mucositis requires

- Visual inspection demonstrating the presence of peri-implant signs of inflammation: red as opposed to

*Corresponding author: Aishwarya Shirude,
PG Student, Sinhgad Dental College and Hospital, Pune, India.

pink, swollen tissues as opposed to no swelling, soft as opposed to firm tissue consistency;

- Presence of profuse (line or drop) bleeding and/or suppuration on probing;
- An increase in probing depths compared to baseline; and
- Absence of bone loss beyond crestal bone level changes resulting from the initial remodelling (Renvert, 2018).



1st European Workshop on Periodontology (EWOP) (Albrektsson & Isidor 1994).

Peri-Implantitis: Peri-implantitis has been defined as an inflammatory lesion of the mucosa surrounding an endosseous implant and with progressive loss of supporting peri-implant bone (Renvert, 2018). As proposed by the Workgroup 4 of the 9th European Workshop in Periodontology, peri-implantitis is an inflammatory condition that refers with a threshold of 2mm of radiographic bone loss from the implant-smooth interface (Pulluri, 2017)".

Peri-implantitis: Case definitions for day-to-day clinical practice

The diagnosis of peri-implantitis requires:

- Evidence of visual inflammatory changes in the peri-implant soft tissues combined with bleeding on probing and/or suppuration;
- Increasing probing pocket depths as compared to measurements obtained at placement of the supra-structure;
- Progressive bone loss in relation to the radiographic bone level assessment at 1 year following the delivery of the implant-supported prosthetics reconstruction;
- In the absence of initial radiographs and probing depths, radiographic evidence of bone level ≥ 3 mm and/or probing depths ≥ 6 mm in conjunction with profuse bleeding represents peri-implantitis (Renvert, 2018).

Ailing, Failing and Failed Implants

According to Askary et al. (2014)

- **Ailing Implants:** Implants exhibiting soft tissue problems exclusively are classified as ailing and have a more favorable prognosis.
- **Failing Implant:** An implant that is progressively losing its bone anchorage, but is still clinically stable, can be defined as failing.
- **Failed Implant:** Implant with mobility excessive bone loss ($\geq 70\%$) not amenable to treatment are failed implant (Galagali, 2014).

Classifications: Peri-implant conditions have been classified under various categories by various authors. Some of them are as follows:

Jovanovic & Klinge 1990, Spiekermann 1991

On the basis of

- Clinical status of peri-implant bone
- Required therapy

Forum-Rosen Peri-implantitis classification (2012): Based on the severity of the disease.

Renvert and Claffey classification(2013):

Based on radiographic presentation of peri-implant bone loss (2013)

Peri-implant bone defects were classified as follows:

Type 1, saucer-shaped: Bone pocket characterized by a concave bottom (classified as type 4, if the undercut was below the alveolar bone crest).

Type 2, wedge-shaped: Bone pocket characterized by a straight or convex wall.

Type 3, flat or no pocket: No pocket present or angle between flat alveolar crest and implant surface $\geq 90^\circ$.

Type 4, undercut: Bone pocket characterized by a concave bottom, with obvious undercutting, that is, with an undercut >0.5 mm and proportion of undercut $>50\%$.

Type 5, slit-like: Bone pocket is narrow and deep, with a width of ≤ 0.5 mm and a depth equaling twice the width or more, or an undercut >0.5 mm and proportion of undercut $<50\%$.

Schwarz et al.(2017) classified peri implant defect depending on the configuration of the bony defect as (Passi et al., 2017):

Class I defect – Intraosseous. Class II defect – Supra-alveolar in the crestal implant insertion area. This Classification informs about only two classes. No clinical and radiological interpretation is evident.

Spiekermann et al (2017) characterized peri-implant defect into the **type of bone resorption** pattern into 5 categories (Passi, 2017).

- Class I – Horizontal,
- Class II – Hey-shaped
- Class III a – Funnel shaped
- Class III b – Gap-like
- Class IV – Horizontal-circular form

Based on amount of bone loss with shaped of defect associated (2017)

Class 1: Slight horizontal bone loss with minimal peri-implant defects.

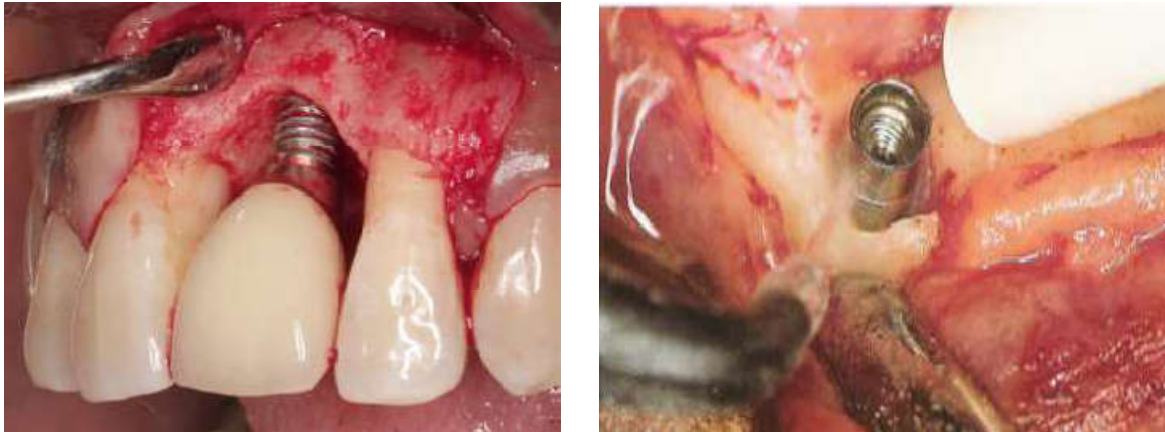


Figure 1

Table 1. Classification of Peri-implantitis

Early	PD ≥ 4mm (bleeding and/or suppuration on probing*)	Bone loss < 25% of the implant length
Moderate	PD ≥ 6mm (bleeding and/or suppuration on probing*)	Bone loss 25% to 50% of the implant length
Severe	PD ≥ 8mm (bleeding and/or suppuration on probing*)	Bone loss >50% of the implant length

Table 2.

	Signs of Disease	Advised Treatment Regimen
Peri-implant Mucositis	<ul style="list-style-type: none"> • Inflammation • BOP • PPD<4mm • No bone loss 	Non-surgical instrumentation and disinfection with chlorhexidine
Peri-implantitis Grade 0	<ul style="list-style-type: none"> • Failure of osseointegration • Implant fracture • Implant > 1mm horizontal movability 	Explant
Peri-implantitis Grade 1 (mild)	<ul style="list-style-type: none"> • BOP+/-SUP • PPD<4 mm • Bone loss < 2 mm • Foreign body in peri-implant sulcus 	Removal of abutment , Non surgical instrumentation and disinfection
Peri-implantitis Grade 2 (moderate)	<ul style="list-style-type: none"> • BOP+/-SUP • PPD 4-6 mm • Bone loss< 2 mm 	Removal of abutment Non surgical instrumentation and disinfection
Peri-implantitis Grade 3 (severe)	<ul style="list-style-type: none"> • BOP+/-SUP • PPD >6 mm • Bone loss> 2 mm 	Removal of abutment Surgical access Instrumentation and disinfection Systemic antibiotics ? resective or regenerative therapy

Table 3.

	Management	Clinical condition
I	Normal maintenance	No pain or tenderness upon function 0 mobility < 2mm radiographic bone loss from initial surgery Probing depth<5 mm No exudate history
II	Reduction of stress Shorter intervals between dental hygiene appointments Gingivoplasty Yearly radiographs	No pain 0 mobility 2-4 mm radiographic bone loss Probing depth 5 to 7 mm No exudate history
III	Reduction of stress Drug Therapy (antibiotics, chlorhexidine) Surgical reentry and revision Change in prosthesis or implants	No pain upon function 0 mobility Radiographic bone loss> 4mm Probing depth> 7mm May have history of exudate
IV	Removal of implants	Any of the following: Pain upon function Mobility Radiographic bone loss >1/2 of the length Uncontrolled exudate No longer in mouth

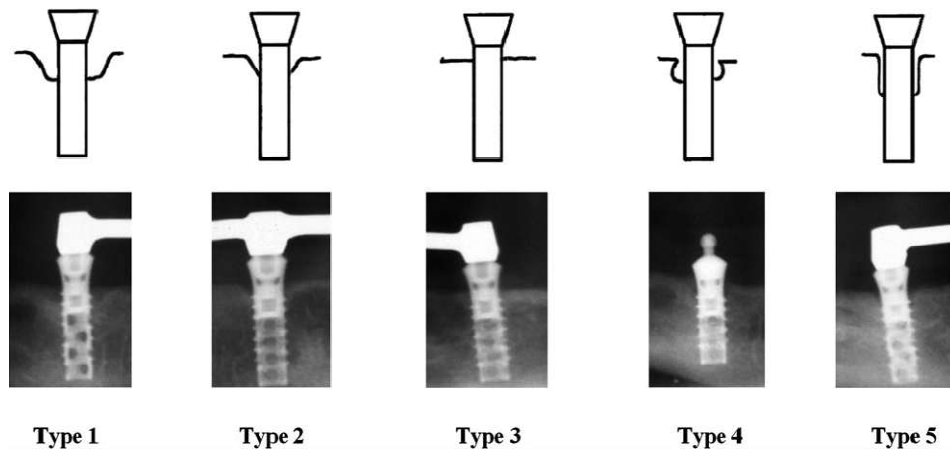
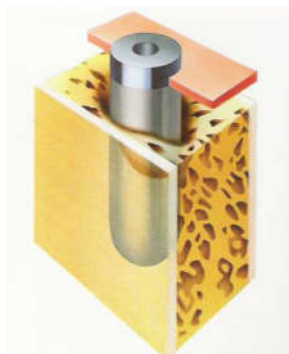


Figure 2.

Class 2: Moderate horizontal bone loss with isolated vertical defects.

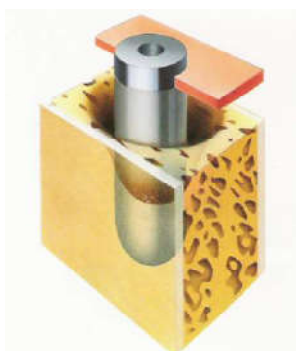


(Figure 3)¹⁴



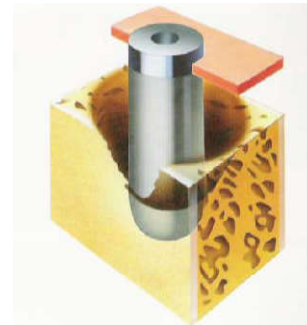
(Figure 4)¹⁴

Class 3: Moderate to advanced horizontal bone loss with broad, circular bony defects.



(Figure 5)¹⁴

Class 4: Advanced horizontal bone loss with broad, circumferential vertical defects, as well as loss of the oral and/or vestibular bony wall. A new classification of bone defects adjacent to dental implants highlighting the **defect anatomy** in the progression of the regenerative process (Passi, 2017).



(Figure 6)¹⁴

Closed Defects: It is characterized by the maintenance of intact surrounding bone walls.

Open Defects: It is the one which lack one or more bone walls.¹⁴

Early Peri-implantitis: (Froum, 2012) PD \geq 4 mm, Bleeding and/or suppuration on probing, Bone loss <25% of the implant length.

Moderate Peri-implantitis: PD \geq 6 mm, Bleeding and/or suppuration on probing, Bone loss ranging from 25% to 50% of the implant length.

Advanced Peri-implantitis: PD \geq 8 mm, Bleeding and/or suppuration on probing, Bone loss >50% of the implant length (Ata-Ali, 2015).

Zhang L et al. demonstrated classification of peri-implant bone defects (PIBDs) on the basis of their panoramic radiographic shapes in patients with lower implant-supported over dentures (Passi, 2017). They are broadly classified into decreasing order of occurrence.

- Saucer-shaped defects
- Wedge-shaped defects
- Flat defects
- Undercut defects
- Slit-like defects

Table 4.

Staging	Definitions
Stage 0A	PPD ≤ 4 mm and BoP and/or SUP, with no signs of loss of supporting bone following initial bone remodeling during healing
Stage 0B	PPD > 4 mm and BoP and/or SUP, with no signs of loss of supporting bone following initial bone remodeling during healing

Table 5.

Staging	Definitions
Stage I	BoP and/or SUP and bone loss ≤ 3mm beyond biologic bone remodeling
Stage II	BoP and/or SUP and bone loss > 3mm and < 5mm beyond biologic bone remodeling
Stage III	BoP and/or SUP and bone loss ≥ 5 mm beyond biologic bone remodeling
Stage IV	BoP and/or SUP and bone loss ≥ 50% of the implant length* beyond biologic bone remodeling

Table 6.

Stage	Result	Therapy
A	Pocket depth (PD) < 3mm, no plaque or bleeding PD < 3mm, plaque and/or bleeding on probing	No therapy required Mechanical cleaning and polishing, oral hygiene maintenance instructions
B	PD 4-5mm, radiographically No bone loss	Mechanical cleansing and polishing, oral hygiene maintenance instructions plus local anti-infective therapy (e.g. Chlorhexidine)
C	PD > 5mm, radiographically bone loss < 2mm	Mechanical cleansing and polishing, microbiological test, local and systemic antibiotic therapy
D	PD > 5mm, radiographically bone loss > 2mm	Respective or regenerative surgery

Table 7. Osseointegration concept of oral implant failures.19

Types of failure	Effects
1. Biological	Failure to establish osseointegration,
a. Early or primary (before loading)	Failure to maintain the achieved osseointegration.
b. Late or secondary (after loading)	Failure of implants, Connectingscrews, bridgeframeworks, coatings etc.
2. Mechanical	Nerve damage, wrong alignment of implants, sinus perforation, devitalization of adjacent teeth etc.
3. Iatrogenic	
4. Inadequate patient adaptation	Phonetical, aesthetical, psychological problems etc.

Table 8. Chronological basis of dental implant failures.19

Types of failure	Cause
1. Early	Surgical trauma, inadequate bone volume, lack of primary stability, intraosseous infection and bacterial contamination of receptor zone
2. Late	Microbiological (peri-implantitis) and biomechanical changes (occlusal overload)

Table 9.

Nonsurgical Therapy	Surgical Therapy	Combination
Mechanical therapy	Implantoplasty	Cumulative
Adjunctive antimicrobials	Guided bone regeneration	Interceptive
Photodynamic therapy	Peri-implant respective therapy	Surgical therapy (CIST)
Local drug delivery	Explantation	
Laser		

Microflora of Peri-implantitis: The microbiological profiles were similar around teeth and dental implants of equal pocket depth, which may indicate that pockets around teeth can serve as a reservoir for putative periodontal pathogens (Shasmitha, 2016). The microorganisms most commonly related to the failure of an implant are the Gram-negative anaerobes, such as *Prevotella intermedia*, *Porphyromonas gingivalis*, *Aggregatibacter actinomycetemcomitans*, *Bacteroides forsythus*, *Treponema denticola*, *Prevotella nigrescens*, *Peptostreptococcus micros*, and *Fusobacterium nucleatum*, anaerobic spores and other bacterial species (Shasmitha, 2016).

Organisms those are less frequently associated with periodontitis, such as *Staphylococcus* spp, enterics, and *Candida* spp, have been found in cases of Peri-implant infection. High counts of *T. forsythia*, *P. gingivalis* and *T. denticola* have been observed in implants with peri-implantitis. Black pigmented *Bacteroides* and *Fusobacterium* spp. were regularly found. Spirochetes, fusiform bacteria as well as motile and curved rods were a common feature in the darkfield microscopic specimens of these sites (Shasmitha, 2016). Healthy peri-implant sites are characterized by high proportions of coccoid cells, a low ratio of anaerobic/aerobic species, a low level of Gram-negative species, and low

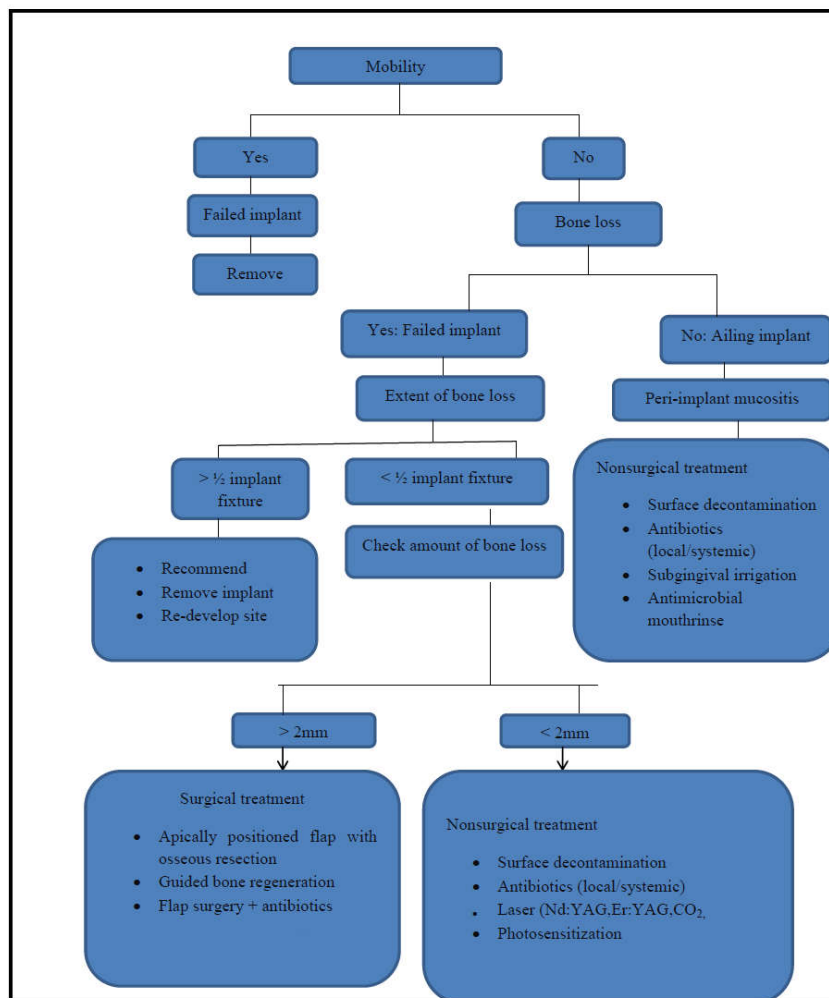


Figure 7.

detection frequencies of periodontal pathogens (Khashu, 2012). Other more unusual oral species, such as *Pseudomonas aeruginosa*, *Enterobacteriaceae*, *Candida albicans* and *Staphylococci* can also be recovered from failing implants (Khashu, 2012). Collectively, many studies indicate that microorganisms colonizing implants in subjects with periodontitis are similar to that observed in the samples from periodontal pockets in the same individuals and harbor more anaerobic species than observed in fully or partially edentulous subjects with minimal or no periodontal diseases (Shasmitha, 2016).

Types of implant failure: Osseointegration was the hallmark of success in implant dentistry in the 1980s (Ashley, 2003). Implant success in the 21st century involves other factors including (Ashley, 2003):

- Stability of the implant
- Adequate radiographic bone levels
- Lack of symptoms or evidence of infection
- Minimal probing depths around the implant
- The ability of the patient to keep the area clean

On the basis of osseointegration Concept and chronology oral implant failures have been classified as follows (Gupta, 2016)

Treatment of Peri-Implant Diseases: Aljateeli M, Fu JH, Wang HL in 2012 proposed a decision tree for treating

Peri-Implant Diseases (Pulluri, 2017). Lang *et al* in 2004 gave consensus statements and recommendations for clinical procedures regarding implant survival and complications.⁷

Conclusion

Even though implants have been used from past over a decade in treatment of edentulous and partially edentulous patients there has been a lack in the study of peri-implant diseases. Understanding the various aspects of these peri-implant diseases make it easier for us to prevent as well as manage these conditions.

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