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Periimplant diseases and its treatment modalities: A review

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Abstract
Dental implants are widely used and are considered to be one of the most feasible treatment options that can be used to replace missing teeth. The placement of dental implants has become a routine procedure in the oral rehabilitation of totally or partially edentulous patient. Implant treatment effectively restores normal oral function and esthetics and has overall satisfactory survival rates. However, implant therapy has certain drawbacks and risks, such as inflammation of peri-implant soft and hard tissues. This review article will provide insights regarding different treatment modalities for treating peri-implant diseases.

Keywords: Peri-implantitis, peri-implant mucositis, dental implants, regeneration

Introduction
Dental implants have become an Invaluable therapy for the replacement of missing teeth in different clinical situations. A recent systematic review showed that at the patient level and implant level data, implant survival was 93.8% and 95.0%, respectively. The corresponding survival rate for original crown restorations was 89.5% over period of 10 years [1] Even if their long-term survival rates are high, complications of mechanical as well as of biological origin might occur [2]. According to Esposito, implant failures can be broadly divided into two categories: (a). Early failures, which occur due to premature loading, surgical trauma or an impaired host healing response and (b). Late failures, which occur due to overloading and bacterial infection [3]. Complications of biologic origin include peri-implant mucositis and peri-implantitis. Peri-implant health is characterized by the absence of erythema, bleeding on probing, swelling, and suppuration [4]. Peri-implant mucositis has been defined as a reversible inflammatory reaction in the soft-tissue surrounding an implant in function, whereas periimplantitis has been defined as a more profound inflammatory lesion characterized by a deepened peri-implant pocket and loss of supporting bone around a functional implant [5, 6]. More recent definition given by 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions include [4]:
Peri-implant mucositis-The presence of bleeding and/or suppuration on gentle probing with or without increased probing depth compared with previous examinations & the absence of bone loss beyond crestal bone level changes resulting from initial bone remodelling. (Fig no 1)
Peri-implantitis - The presence of bleeding and/or suppuration on gentle probing & Increased probing depth compared with previous examinations & The presence of bone loss beyond crestal bone level changes resulting from initial bone remodelling.(fig no 1)

Retrograde Peri-implantitis
McAllister *et al.* reported another entity separate from peri-implantitis known as retrograde peri-implantitis. It is characterized clinically as symptomatic peri-apical lesion that develops within the first few months after implant insertion while the coronal portion of the implant sustains a normal bone to implant interface. It can be an active or an inactive lesion [7].

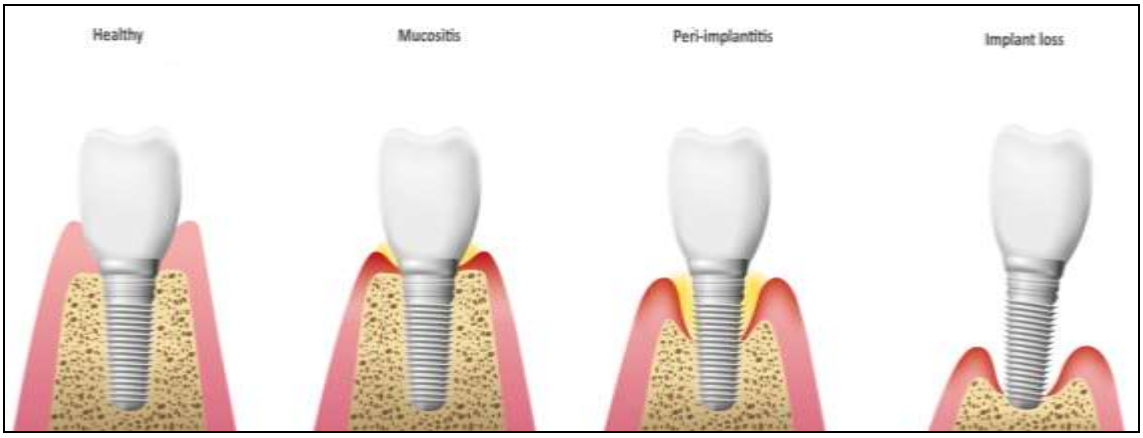

Fig 1: Bone level changes around implant in health and disease

Prevalence of Peri-Implant Diseases

Wide range of studies regarding prevalence for peri-implant biological complications has been reported in the literature. Derks *et al.* [8] reported prevalence of periimplantitis from 4% to 45% according to the definition used and sample population. A systematic review of the literature reported a prevalence of peri-implant mucositis of 43% (range 19–65%) and peri-implantitis of 22% (range 1–47%) [9]. Various systematic reviews and meta analysis showed prevalence for peri-implant mucositis of 42.9%, of 29.48% (implant level) or 46.83% (patient-based) for peri-implantitis it was implant level (21.7%, 9.25%, 1.1–85%, 12.8%) and those on patient level (19.83%, 0–39.7%, 18.5%) [10, 11, 12].

Etiology of peri-implant diseases

Peri-implantitis results due to impaired balance between bacterial and host response following failure of osseointegration of the implant with bone [13]. The formation of the biofilm is considered to be the primary etiological factor for the peri-implant diseases. The bacterial plaque colonizes the implant surface as it colonizes a natural tooth the biofilm of the peri-implant tissue reaches the epithelium and subgingival connective tissue. As it progresses around the implant the microbiota will potentially be in proximity of the supporting bone leading to loss of bone eventually which will lead to the loss of the implant. The microbiota includes anaerobic bacterial species such as Porphyromonas gingivalis, Prevotella intermedia, *Eikenella corrodens*, Actinomyces naeslundi. Many studies have shown presence of Staphylococcus aureus on the implant surface which has capacity to adhere to titanium. However, literature demonstrates that there are several other influencing factors which includes: [14]

i) Poor Oral Hygiene
ii) Implant surfaces
iii) History of Periodontitis
iv) Occlusion
v) Excess cement
vi) systematic diseases (Diabetes, osteoporosis)
vii) Tobacco

Diagnosis of Peri-Implantits

Early diagnosis is the key in treating peri-implant diseases. Various parameters are assessed for the diagnosis which include [15]:

i) Peri-implant radiography-Marginal bone height is an important diagnostic parameter for peri-implant diseases. For the precise assessment of bone level changes standardized radiographs are required.
ii) Peri-implant probing- peri-implant probing has been suggested as a useful diagnostic procedure which provides information regarding probing depth, bleeding on probing and suppuration
iii) Implant mobility -is an indication for lack of osseointegration. Mobility is not a good indicator in detecting the early stages of peri-implant disease, it serves as good indicator in the final stage of Osseo disintegration and may help to decide that an implant has to be removed.
iv) Suppuration-Histologic examination can provide information regarding activity of the disease.
v) Clinical indices-Indices aid in detecting clinical signs like bleeding on probing, swelling, redness and suppuration.
vi) Microbiology -Bacterial culture, DNA probes, polymerase chain reaction, monoclonal antibody and enzyme assays aid in detecting the subgingival microflora which helps in determining an elevated risk for periodontal disease or peri-implantitis.

In 2016 Ramanauskaite and Juodzbalys proposed a Rationale for diagnosis and prognosis of peri-implantitis [16]. (Fig no 2)

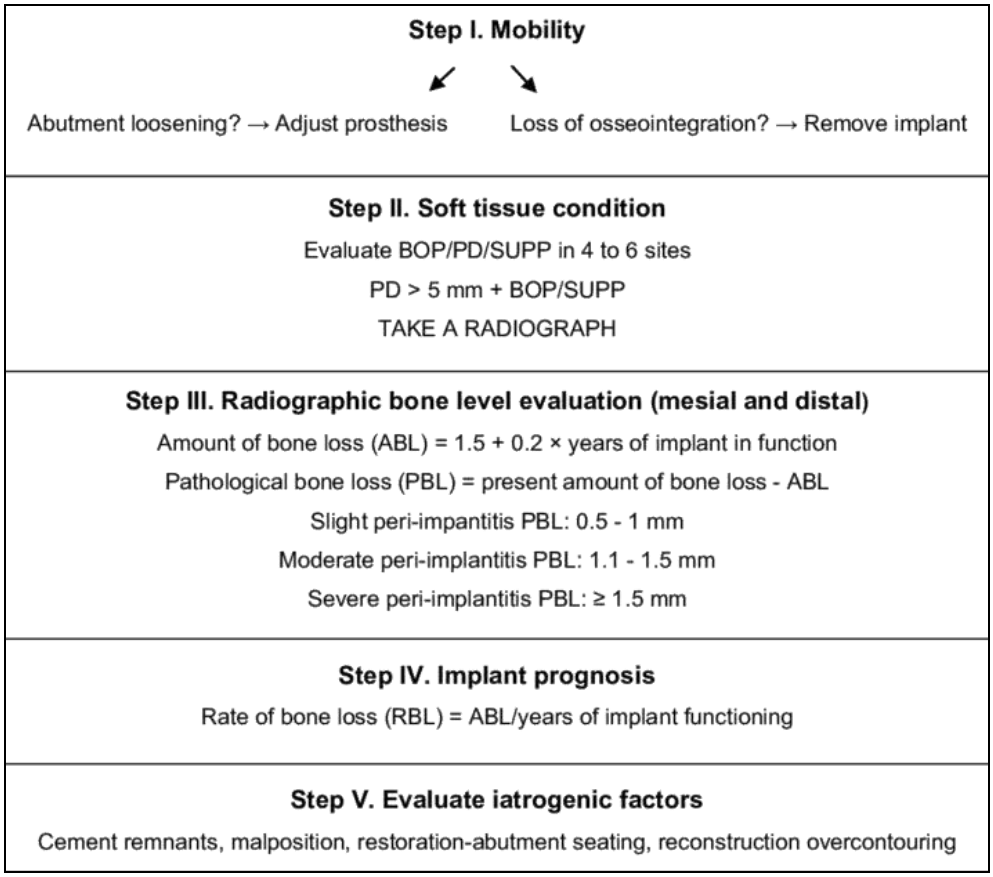

Fig 2: Rationale of diagnosis and prognosis of peri-implantitis

Treatment Modalities for Peri-Implant Diseases

Treatment Therapies for Peri-Implant Mucositis

Non surgical therapy is sufficient for treating peri-implant mucositis due to its reversible nature. Various treatment modalities include:

i) Mechanical therapy: This includes mechanical decontamination using combination of hand (i.e., titanium, plastic, Teflon, carbon-fiber) and mechanical (i.e., abrasive air powder systems, rubber cup) instruments [17] (Figure no 3)

Blasi *et al.* carried out multicentre study using four tools i.e sonic plastic tips, titanium curettes, airflow with glycine powder or rubber cups and polishing paste which showed decrease in bleeding on probing but without any statistically significant difference [18].

More recently chitosan brushes have been used to treat peri-implant mucositis. J. C. Wohlfahrt *et al.* carried out multicentre study where 63 implants were placed with mild peri-implantitis defined as radiographic bone loss of 1–2 mm, pocket probing depth (PPD) ≥4 mm and a positive bleeding on probing (mBoP) score were treated with chitosan brush. After 6 months stable reductions in PPD and mBoP were evident (Figure no 4) [19].

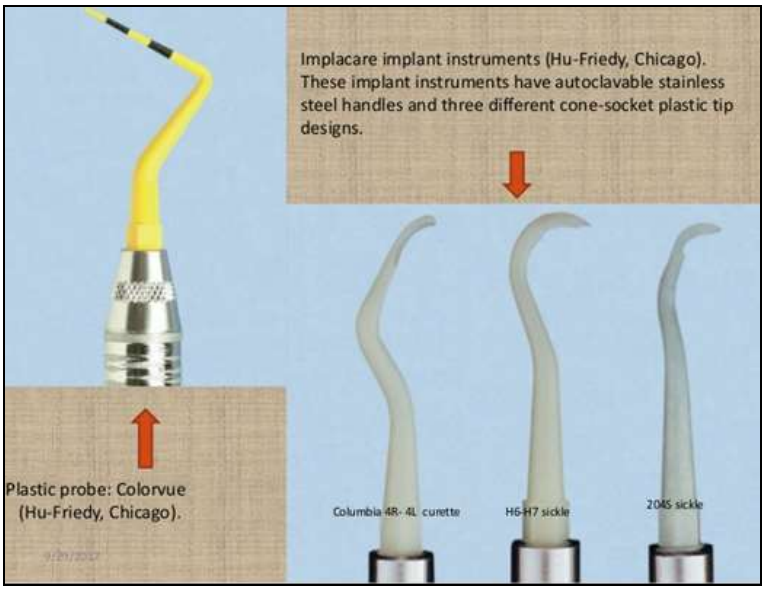

Fig 3: Types of Probes and Curettes for Periimplant diseases

ii) Chemical therapy- Several chemical adjuncts to mechanical debridement have been used for treating peri-implant mucositis**.** Gosau *et al.* [20] carried out *in vitro* study on biofilm reduction on titanium specimens affixed to removable dental appliances and found that antimicrobial substances, such as sodium hypochlorite, 3% hydrogen peroxide, 0.2% chlorhexidine digluconate and essential oils, were able to reduce bacteria in the biofilm that developed on a titanium surface, as compared with saline solution. Also found that 0.5% cetylpyridinium chloride and 40% citric acid were not effective in reducing biofilm.

Lorio-Siciliano *et al.* [21] used sodium hypochlorite as an adjunct to mechanical debridement and compared with mechanical debridement alone (ultrasonic scaler). A 5× application for 30 s of NaOCl gel prior to mechanical debridement with an ultrasonic scaler failed to statistically significantly improve PD and BoP reductions compared with mechanical debridement alone.

Flichy-Fernández *et al.* [22] reported the positive effects of the adjunctive delivery of tablets containing Lactobacillus reuteri (dosage: 1 × 30 days) on 23 implants diagnosed with peri-implant mucositis. Adjunctive probiotics delivery showed Pocket Depth reduction of 1.09 SD 0.90 mm compared with the placebo group after 6 months.

Kashefimehr *et al.* [23] used EMD (enamel matrix derivative) around dental implants diagnosed with peri-implant mucositis. Submucosal mechanical debridement, adjunctive EMD application yielded statistically significantly lower Pocket Depths as well as lower BoP percentages at the 3-month follow-up.

iii) Laser therapy and Photodyanamic therapy -Many studies have been carried out regarding use of lasers and photodynamic therapy in treatment of peri-implant diseases but it has failed to show any improvements in treating peri-implant diseases. Guo-Hao Lin *et al.* [24]in their best evidence review showed laser therapy in combination with surgical/non-surgical therapy provided minimal benefit in PD reduction, CAL gain, amount of Recesssion improvement, and PI reduction in the treatment of peri-implant diseases. Lasers when used as an adjunct to non-surgical therapy might result in more BOP reduction in the short term. Albaker *et al.* [25] in their systematic review did not find any conclusive effect of PDT or LT in the management of peri-implant mucositis.

Treatment modalities for peri-implantitis

Non-surgical treatment

i) Mechanical therapy-In recent times many instruments have been developed for debridement of implant surface like titanium or carbon-fiber scalers, ultrasonic devices with plastic or Teflon-coated tips. (Fig no 4) [26].

Renvert *et al.* [27] compared titanium curettes and an ultrasonic device reduction in bleeding on probing was noted but pocket depth did not improve after 6 months. Sahm *et al.* [28] compared the efficacy of glycine powder with an air-polishing device with mechanical debridement with carbon fiber curettes and chlorhexidine digluconate after 12 months which showed reduction in bleeding on probing.

Fig 4: Teflon coated tips for ultrasonic devices

ii) Antiseptic Therapy: Levin *et al.* [29] in their RCT showed the adjunctive at-home use of water jet with chlorhexidine (CHX) gel and found 0.5 mm PD reduction.

Machtei *et al.* [30] in a multicenter, placebo-controlled RCT on ultrasonic debridement with adjunctive use of an antiseptic CHX releasing matrix at 2, 4, 6,8, 12, and 18 weeks showed in both BOP and PD with clinical attachment level (CAL) gain.

iii) Antibacterial therapy: Renvert *et al.* [27] showed adjunctive use of minocycline with mechanical debridement lead to reduction pocket depths over period of 6 months.

Mombelli *et al.* [31] treated 30 lesions with mechanical debridement and placement of tetracycline fibers. Mean improvements in clinical parameters resulted, which were sustained over a 12-month observation period.

Alfredo De Rosa [32] *et al.* carried out *in vitro* study using controlled-Release material Containing Metronidazole and Doxycycline for peri-implantitis. It was concluded that newly formulated gel was effective both on planktonic species and on bacterial biofilm over a period of 13 days

iv) Laser and Photodyanmic therapy: Various types of lasers have been used: neodymium-doped: yttrium aluminium garnet, Erbium: yttrium aluminium garnet (Er: YAG), CO2 and Diode laser with variable results [33]. Kotsakis *et al.* [34] in their meta-analysis and systematic showed with a single application of either an erbium: yttrium-aluminum-garnet

(Er:YAG) (2,940-nm) laser or a diode (660-nm) laser in combination with a phenothiazine chloride dye is efficient in controlling inflammation around treated implants for at least 6 months but showed no statistically significant evidence for treatment effects in reducing PD and CAL levels in comparison to controls.

Sivaramakrishnan and Sridharan [35] in their meta-analysis showed significant reduction in the level of attachment scores with the use of combined photodynamic therapy with mechanical debridement when compared with other interventions tested. For bleeding on probing, pocket depth and plaque scores no statistically significant results were obtained.

Decision tree on nonsurgical treatment of periimplantitis is illustrated in figure no 5 [36].

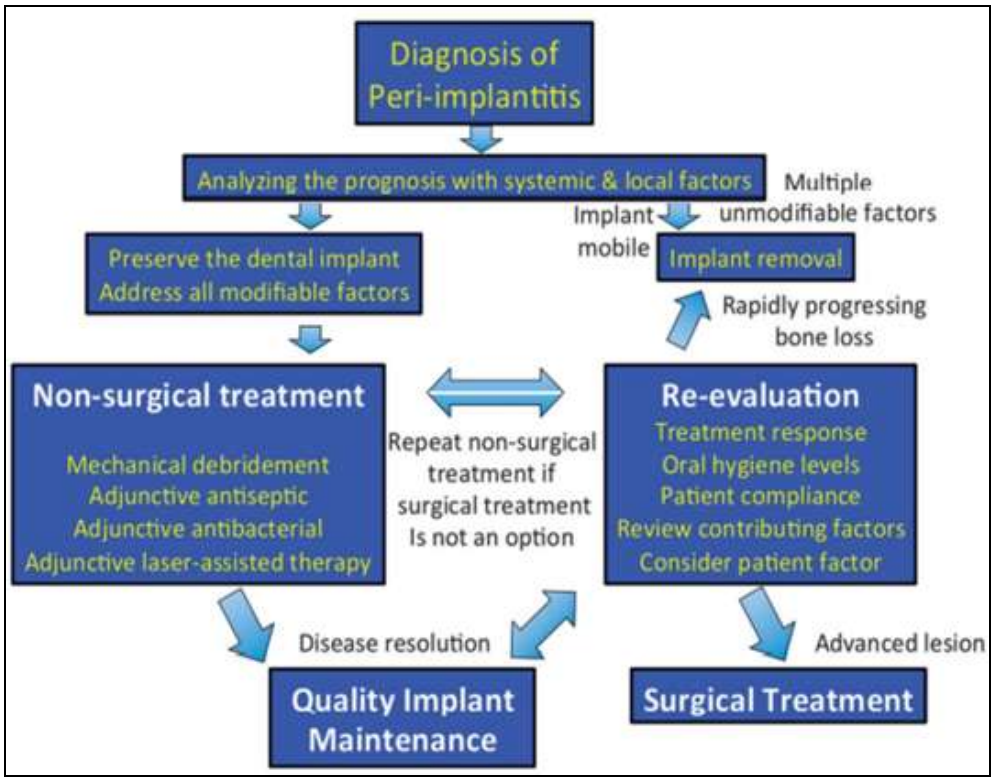

Fig 5: Decision tree for non-surgical treatment of peri-implantitis

Surgical Treatment

Any surgical intervention should be initiated after mechanical debridement and decontamination has been performed [33]. The main aim of the surgical treatment is to gain direct access to the infected site, facilitating removal of granulation tissue.

Treatment modalities can be divided into two [37]:

Non-Augementative Procedures

I) Implantoplasty- Implantoplasty is a surgical procedure performed to smoothen the threads of exposed implants to provide surface which will decrease the adherence of biofilm.It is carried out by high speed diamond burs and polishers [38]. (Fig no 6)

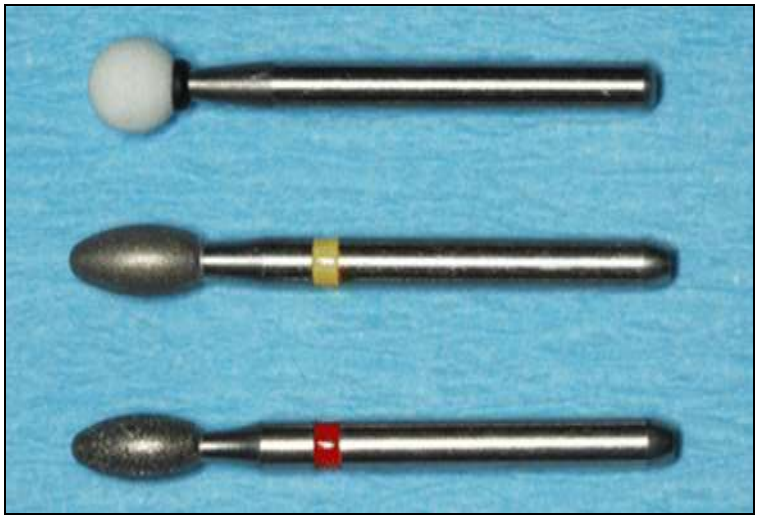

Fig 6: Burs for Implantoplasty

ii) Open Flap Debridement: Open flap debridement is a surgical procedure to gain access to implant site for removal of granulation tissue and decontamination. Leonhard *et al.* [39], in a study, with follow ups upto 5 years after surgery showed that the 26 implants 6 of them obtained bone reconstruction, 7 implants were lost, while 4 implants bone resorption has

continued. This study showed that treatment protocol may be useful in controlling peri-implant lesions.

iii) Resective therapy: Resective therapy include apically positioned flap combined with osteoplasty and implantoplasty. The basic principles include the elimination the peri implant osseous defect using ostectomy and osteoplasty. It is indicated in moderate to severe horizontal bone loss, vertical bone defects (1 and 2 wall bone defects). [40] Berglundh *et al.* [41], in their retrospective study showed significantly higher PD and BOP reduction as well as greater crestal bone preservation for the implants with nonmodified surfaces 2 to 10 years after the resective therapy.

Augmentative Procedures

The main aim of augmenatative procedure includes
i) regeneration of bony defects ii) re-osseointegration iii) prevention of peri-implant soft tissue recession [41].

Thoma *et al.* [42] in their systematic review and meta-analysis showed soft tissue grafting improved peri-implant health. Autogenous grafts showed a greater improvement of bleeding indices and higher marginal bone levels and gain of mucosal thickness using autogenous grafts showed significantly less marginal bone loss.

Schwarz *et al.* [43] in their systematic review and meta-analysis showed improvement in marginal bone levels, clinical attachment gain, and reduction of the PD at peri-implantitis sites treated with natural bone mineral in combination with a collagen membrane.

Wiltfang *et al.* [44]. in their clinical trial showed significant bone fill treated with surface decontamination and regenerative flap surgery with autogenous and xenogeneic bone graft for period of 12months.

Decision tree for management of peri-implant diseases was given by Okayasu, K. & Wang, H.-L [45]. Illustrated in figure no 7.

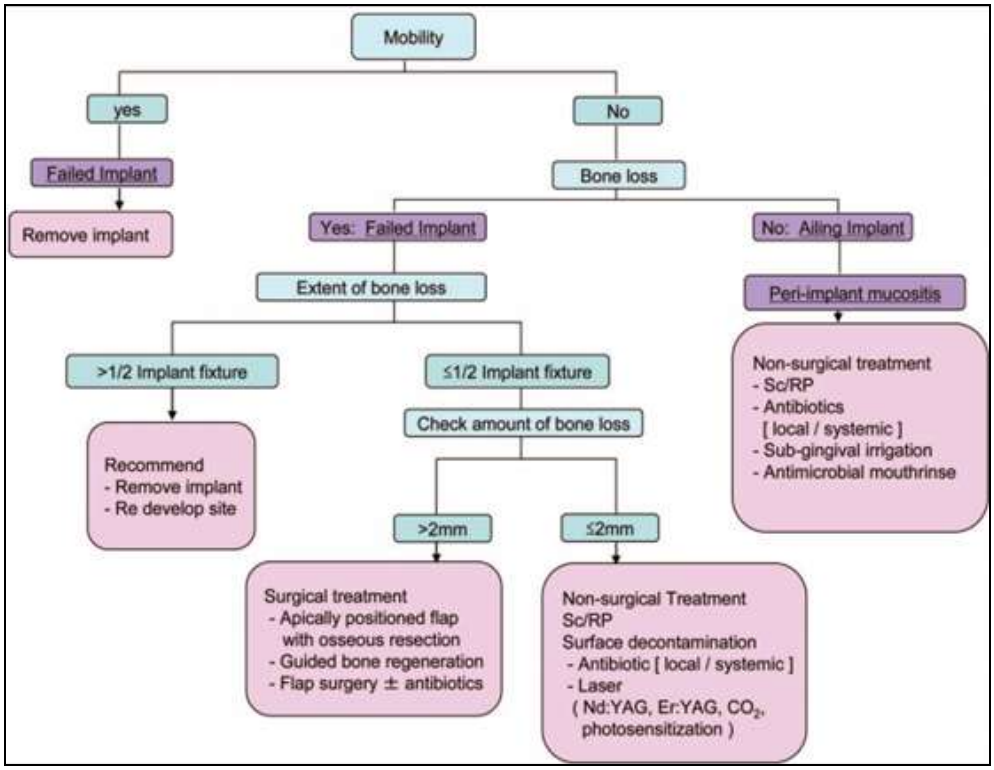

Fig 7: Overall decision tree for peri-implant diseases

Cumulative Interceptive Supportive Therapy (CIST)

It is a step-wise therapeutic procedures carried out in treatment of peri-implant diseases. It is divided into four parts [46, 47] (fig no 8)

Part A: Performed when plaque and Bleeding on Probing (BOP) are present but Pocket Depths (PD) are 3 mm or less, patients education and motivation regarding oral hygiene should be initiated. Mechanical debridement is performed using non metallic curettes.

Part B: when PDs of 4 to 5 mm are found, consists of antiseptic treatment. Here, chemical plaque control is performed using chlorhexidine digluconate, mouthrinses and chlorhexidine gel (0.2%), and/or local irrigation with chlorhexidine (0.2%), 2 times a day for 3 to 4 weeks.

Part C: Anti-microbial therapy is performed when PD is greater than 5 mm (Ornidazole (1,000 mg 1) or metronidazole (250 mg 3) for 10 days, or combination of amoxicillin (375 mg 3) and metronidazole (250 mg 3) for 10 days).

Part D: After completion of A, B, and C treatment modalities, a surgical approach may be considered.

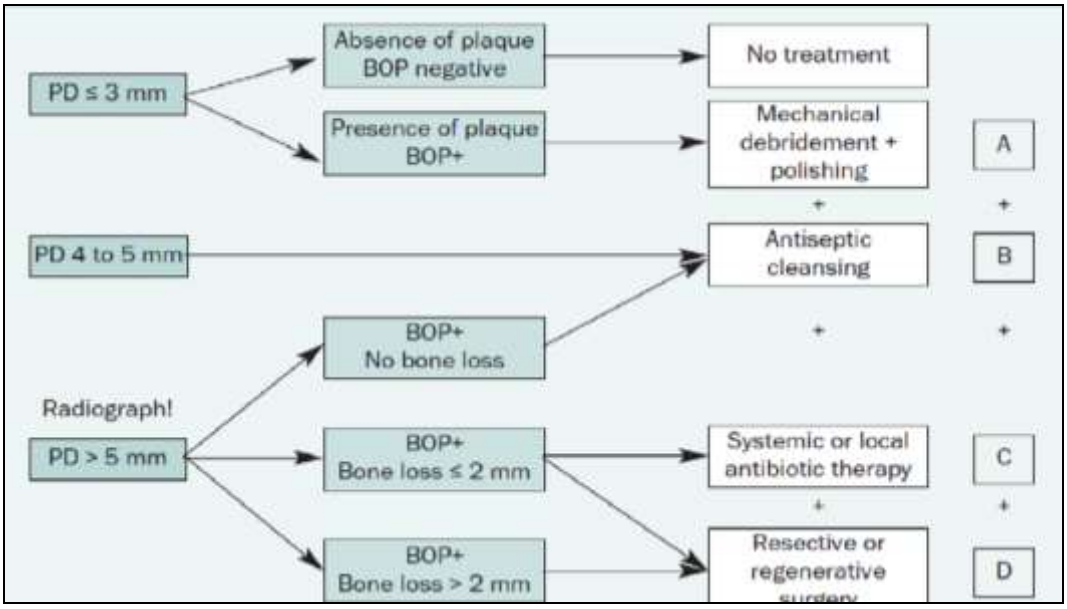

Fig 8: CIST protocol

AKUT-Concept

In 2004 the CIST protocol was modified and called AKUT-concept by Lang *et al.* The basis of this concept is a regular recall of the implanted patient and repeated assessment of plaque, bleeding, suppuration, pockets and radiological evidence of bone loss [46, 48]. Illustrated in fig no 9.

Stage	Result	Therapy
	Pocket depth (PD) < 3 mm, no plaque or bleeding	No therapy
A	PD < 3 mm, plaque and/ or bleeding on probing	Mechanically cleaning, polishing, oral hygienic instructions
B	PD 4-5 mm, radiologically no bone loss	Mechanically cleaning, polishing, oral hygienic instructions plus local antiinfective therapy (e.g. CHX)
C	PD > 5 mm, radiologically bone loss < 2 mm	Mechanically cleaning, polishing, microbiological test, local and systemic antiinfective therapy
D	PD > 5 mm, radiologically bone loss > 2 mm	Resective or regenerative surgery

Fig 9: AKUT concept

Conclusion

The main aim in management of peri-implant diseases is to control infection at an early stage. Early diagnosis of peri-implantitis is imperative. Studies regarding the treatment of peri-implantitis did not show any conclusive evidence that suggests which interventions could be the most effective for treating peri-implantitis. Hence patient education and regular follow ups and maintenance holds key in management of peri-implant diseases.

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