Current concepts in the management of periodontal disease

Periodontitis is a common disorder affecting >40% of adults in the United States. Globally, the severe form of the disease has a prevalence of 11% [1]. Periodontitis is a chronic multifactorial inflammatory disease associated with the accumulation of dental biofilm and characterised by progressive destruction of the teeth-supporting apparatus, including the periodontal ligament and alveolar bone leading to tooth loss [2]. The disease involves complex dynamic interactions among specific bacterial pathogens, destructive host immune responses, and environmental factors such as smoking [3 4]. Periodontitis is multifactorial in nature and results from the presence of pathogenic 1`2bacteria, the host inflammatory and immune responses and other identified environmental and systemic risk factors. According to data from the National Health and Nutrition Examination Survey 2009–2014, 42% of adults in the United States had periodontitis, with 7.8% having severe type [1] This survey confirmed a high prevalence of periodontitis in the United States affecting almost 50% of the adult population (30 years old or older). Globally, approximately 11% of the world population may have severe periodontitis, amounting to 743 million individuals [5]

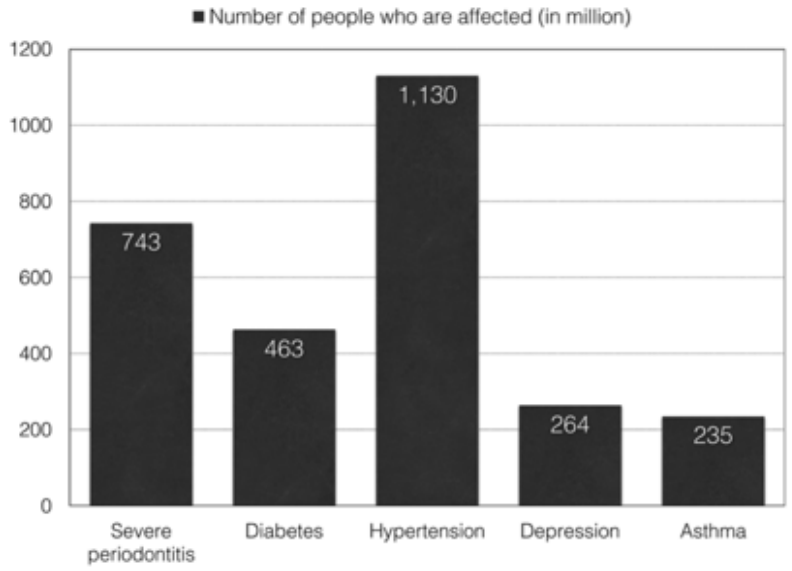


Fig 1. Global prevalence of severe periodontitis in comparison to diabetes hypertension depression and asthma (adapted from Kwon et al [5])

Untreated or inadequately treated periodontitis leads to the loss of tooth-supporting tissues and teeth. Severe periodontitis, along with dental caries, is responsible for more years lost to disability than any other human disease (GBD 2017 Disease and Injury Incidence and Prevalence Collaborators, 2018). Furthermore, periodontal infections are associated with a range of systemic diseases leading to premature death, including diabetes [6] cardiovascular diseases [7] or adverse pregnancy outcomes[8] Thus, periodontal disease and clinical implications including tooth loss, has a substantially negative effect on the individual oral health and overall quality of life. Conversely its successful management and treatment improves patient overall quality of life [9]

Aetiology

Periodontitis is a complex chronic inflammatory disease, in which there are multiple causal components that play their aetiological roles simultaneously and interact with each other. [10]At least five domains of causal risk factors can be distinguished for periodontitis **(see Fig.2):**

1. Environmental factors (a dysbiotic subgingival bacterial biofilm);
2. Genetic risk factors;
3. Lifestyle factors such as smoking, poor diet, and stress;
4. Systemic diseases, such as diabetes;
5. Other factors, as yet unknown but most likely also including tooth-related, occlusal, and iatrogenic factors.

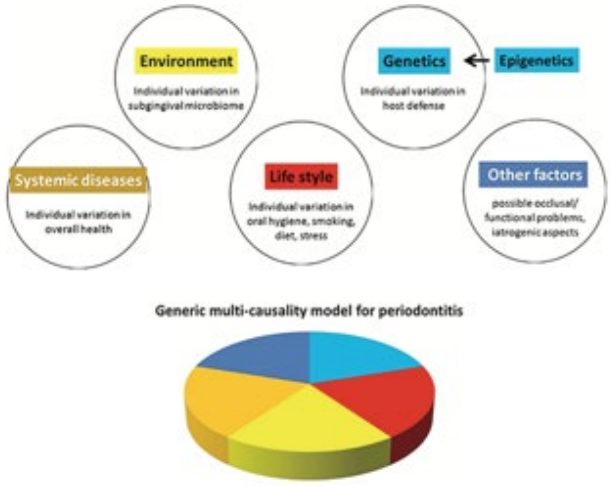


Fig 2 . Periodontitis is multifactorial in nature and results from the presence of pathogenic bacteria, the host inflammatory and immune responses and other identified environmental and systemic risk factors.

Microbial pathogen (Dental biofilm

For a susceptible host, microbial infection in subgingival dental biofilm by periodontal pathogens, in particular a group of specific Gram-negative anaerobic species referred to as the red complex, results in chronic inflammation The red complex, which appears later during biofilm development, comprises species that are considered periodontal pathogens, namely, *Porphyromonas gingivalis, Treponema denticola*, and *Tannerella forsythia*(previous names *Bacteroides forsythus*, or *Tannerella forsythensis*). The red complex presents a portion of the climax community in the biofilms at sites expressing progressing periodontitis

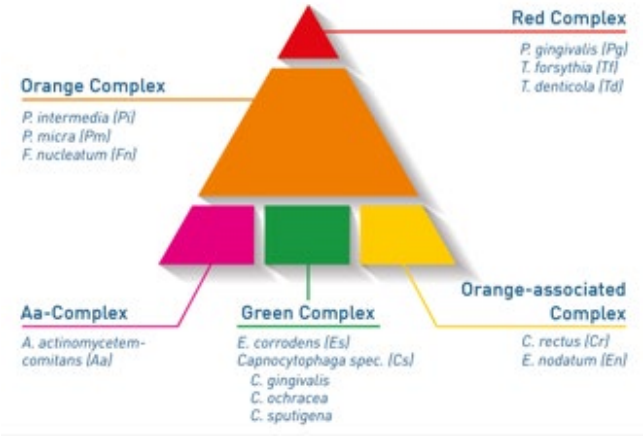


Diagram showing association among subgingival species. The base of the pyramid is comprised of species thought to colonize the tooth surface and proliferate at an early stage

Risk factors

Smoking

Smoking is the most important environmental risk factor for periodontitis. Compared to non-smokers or past smokers, smokers exhibited a significantly higher prevalence of red-complex periodontal pathogens in their subgingival biofilm.[11] Furthermore, a potential negative effect of smoking on host immune cells, especially neutrophils, was reported, making their host more susceptible to periodontitis[12]. Consistent with these findings, light and heavy smokers are at a greater risk for developing alveolar bone loss with an odds ratio of 3.25 and 7.28, respectively, compared to non- smokers. Similarly, light and heavy smokers are at a greater risk for developing periodontal attachment loss with an odds ratio 2.05 and 4.07, respectively, compared to non-smokers[13, 14] Furthermore, smoking has a negative impact on the outcome of active periodontal therapy as well as long-term maintenance periodontal therapy. Thus, patients should be continuously reminded of the importance of smoking cessation for successful management of periodontitis [15, 16]

Diabetes

Patients with uncontrolled diabetes are at a greater risk for developing periodontitis as compared to systemically healthy patients or patients with well-controlled diabetes . The association between diabetes and periodontal disease is partly due to alterations in the immune system of patients with uncontrolled diabetes, which result in impaired neutrophil function or hyper-responsive macrophages producing pro-inflammatory cytokines [17]

Clinically, patients with type 2 diabetes exhibited an increased risk of periodontitis with an odds ratio of 2.81 for clinical attachment loss and an odds ratio of 3.43 for alveolar bone loss[18]. Patients with diabetes exhibit a greater percentage of teeth having at least one site with a probing depth of 5 mm or more, a greater percentage of sites with bleeding on probing, and a greater number of missing teeth compared to non-diabetic patients[19]. Moreover, patients with uncontrolled diabetes may not respond as favorably to periodontal therapy as do patients with periodontitis but milder diabetes. Thus, patients' glycaemic status should be continuously monitored, and haemoglobin A1c (HbA1c) levels should be documented. Ideally, the HbA1c level should be <7.0% [2] For patients with poorly managed diabetes, inter-professional practice is essential

CONTRIBUTING FACTORS

Overhanging/over-contoured restoration

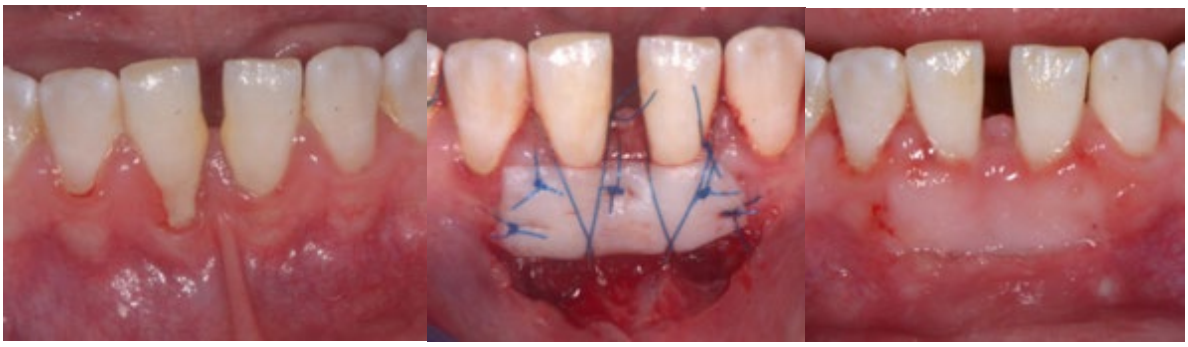
Overhanging or over-contoured restorations may pro- mote dental biofilm retention, initiating a local periodontal lesion [20]. Thus, a restoration with overhang or excessive contour should be eliminated during the course of periodontal therapy to create an environment that allows biofilm removal.

Occlusal trauma

Though occlusal trauma is not considered a risk fac tor for alveolar bone loss or development of periodontal disease, when occlusal trauma is present, periodontitis may exhibit a greater rate of progression. Thus, resolution of occlusal trauma should be considered during periodontal therapy For example, fremitus on centric occlusion or excursive movement should be eliminated in periodontally compromised teeth. Teeth presenting with excessive or increasing mobility as a result of occlusal trauma may be splinted[21].

Mucogingival deformity

The presence of 2 mm or more of attached gingiva is considered necessary to maintain gingival health A significantly higher gingival index was noted for teeth with <2 mm of attached gingiva compared to those with at least 2 mm of attached gingiva· [22] Thus, all mucogingival deformities should be recorded during a comprehensive periodontal evaluation and, if indicated, treated during the phase of surgical periodontal therapy



Diagnosis

The periodontal and peri-implant diseases and conditions classification aids clinicians to diagnose and properly treat patients. A new classification of periodontal diseases and conditions was introduced in 2018, following the deliberations and the consensus reports of an International Workshop that took place in November 2017. The new classification system is quite different from the one published in 1999, because, with the exception of specific forms (necrotizing periodontal diseases and periodontitis as a manifestation of systemic disease) periodontitis is recognized as a single nosological entity that is further classified using a two-vector system (*Stage* and *Grade*). *Stage* reflects the severity of the disease (expressed through *attachment loss* and *bone loss*), but also *tooth loss* that has occurred as a result of periodontitis, at least as well as can be determined. In addition, it reflects anticipated complexity of treatment required to eradicate/reduce the current level of infection and inflammation, and to restore patient masticatory function. *Grade* describes additional biological dimensions of the disease including the observed or inferred progression rate, the risk for further deterioration due to environmental exposures (such as smoking) and co-morbidities (such as diabetes), and the risk that the disease or its treatment may adversely affect the particular patient's general health status. Bleeding on probing (BOP) is a valuable clinical parameter to help assess current levels of inflammation and residual risk post-treatment, but BOP does not influence the classification.[23]

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Assessment of stage

The first step is to define if the patient has periodontitis; this is ideally performed by assessing presence of clinical attachment loss but, importantly, this determination involves clinical judgement: If (1) interproximal attachment loss is present at least at two different, non-adjacent teeth, and (2) the observed attachment loss cannot be attributed to traumatic factors or non-periodontitis related etiologies (e.g., root fracture, endodontic infection, surgical trauma), then the patient has periodontitis. In the absence of interproximal attachment loss, but if attachment loss that cannot be ascribed to non- periodontitis-related causes is present at buccal or lingual surfaces, a diagnosis of periodontitis requires concomitant presence of clinical attachment loss of ≥3 mm and probing depth of ≥3 mm at ≥2 teeth. Clinicians will frequently confirm the presence of attachment loss by corresponding interproximal alveolar bone loss on radiographs. It must be remembered, however, that tissue loss needs to encompass a substantial portion of the buccal-lingual dimension before it can be visualized by conventional radiographs. Thus, absence of readily discernible bone loss does not preclude presence of frank periodontitis of incipient severity. This is exactly the reason why the diagnosis of periodontitis is based on attachment loss rather than bone loss which is admittedly more widely assessed; use of bone loss as the primary criterion.

The vertical red line emphasizes the distinction between Stages I and II (mild/moderate) versus Stages III and IV. (severe/advanced)

A commonly raised issue is how to reliably differentiate between bone loss of up to 15% of the root length versus bone loss extending between 15% and 33% of the root length. The intent is to distinguish between an incipient stage of periodontitis (Stage I) that has barely resulted in alveolar bone loss, from more substantial bone loss that extends within the coronal third of the root length. Clearly discernible inter-proximal bone loss within the coronal third of the root length will, in most situations, be commensurate with Stage II rather Stage I disease. In contrast, Stage I disease is usually characterized by incipient attachment loss in the presence of early radiographic evidence of disruption in the alveolar bone sup- port (e.g., a break in the integrity of *the lamina dura*) rather than pronounced increase in the CEJ-bone crest distance. If the preliminary assessment is that the patient suffers from either Stage III or Stage IV periodontitis, the distinction between these two stages will be based either on the amount of tooth loss that can be attributed to periodontitis (one to four teeth versus five or more teeth lost) or on the presence of the various complexity factors that need to be appreciated in detail. It must be realized that either Stage III or Stage IV disease may reflect severe or very severe periodontitis. However, the primary distinction between the two requires that an experienced clinician ponders the following two central questions:

(1) does the patient's extent and severity of periodontitis constitute a threat for the survival of *individual teeth* or rather of the survival of *the entire dentition*? and

(2) does the total therapy envisioned to address the sequalae of periodontitis in the particular patient involve extensive, multi-disciplinary oral rehabilitation? If the assessment is that the current level of periodontitis threatens the entire dentition and, consequently, treatment requires extensive oral rehabilitation involving collaboration of multiple experts (beyond the need for occasional extractions and a limited prosthetic reconstruction), then the appropriate Stage for the patient is IV rather than III. The following flowcharts are aimed to help clinicians distinguish and diagnose three common periodontal conditions. The diagnosis is not only for a new case, but also for cases that have been treated. In previous patients treated for periodontitis, once periodontal stability is achieved, health or gingivitis can exist even on a reduced periodontium with clinical attachment loss (AL). When signs of active periodontitis remain after treatment, a diagnosis of recurrent periodontitis can be made due to the unsuccessful treatment

Periodontal diagnosis flowchart.

Probing depth (PD) is the first clinical parameter used to categorize the patient. The patient will be classified based on the maximum PD (e.g., ≤3 mm or >3 mm) then full-mouth BOP percentage (e.g., <10% or ≥10%) will be used to determine gingival inflammation. If PD is ≤3 mm with full-mouth BOP <10%, the patient will be diagnosed with "periodontal health."

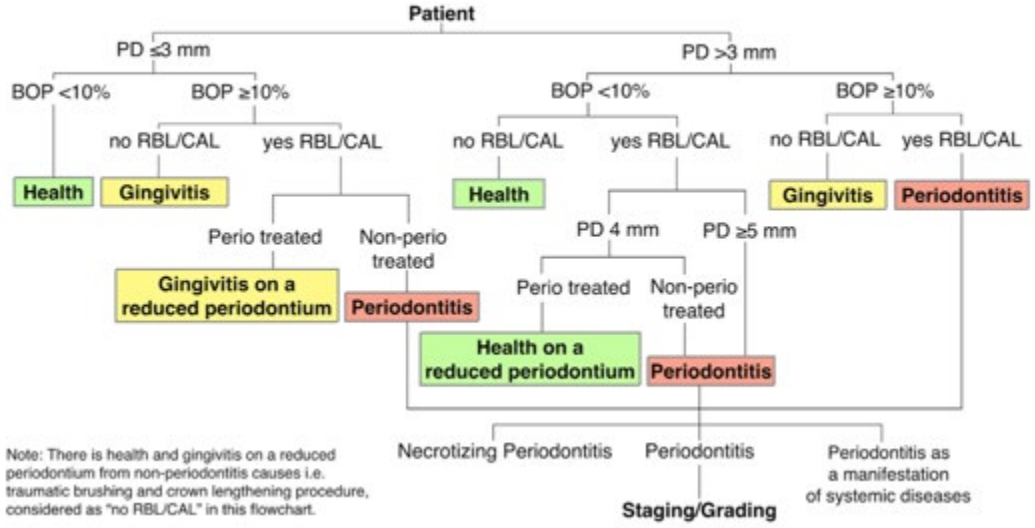
If PD is ≤3 mm and full-mouth BOP is ≥10%, then the detection of radiographic bone loss (RBL) or clinical AL will be needed. In a case without RBL or clinical AL, the patient will be diagnosed with "gingivitis." While in a case with RBL and clinical AL, history of periodontal treatment is needed for the diagnosis. If the patient has been previously treated

Staging a Periodontitis Patient		Initial Periodontitis	Moderate	Severe with potential for tooth loss	Advanced with potential for dentition loss
Periodontitis stage		Stage I	Stage II	Stage III	Stage IV
Severity	Interdental CAL at site of greatest loss	1 to 2 mm	3 to 4 mm	≥ 5 mm	≥ 5 mm
	Radiographic bone loss	Coronal third (<15%)	Coronal third (15% to 33%)	Extending to mid-third of root and beyond	Extending to mid-third of root and beyond
	Tooth loss	No tooth loss due to periodontitis		Tooth loss due to periodontitis of ≤ 4 teeth	Tooth loss due to periodontitis of ≥ 5 teeth
Complexity	Local	Maximum probing depth ≤ 4 mm Mostly horizontal bone loss	Maximum probing depth ≤ 5 mm Mostly horizontal bone loss	In addition to stage II complexity: Probing depth ≥ 6 mm Vertical bone loss ≥ 3 mm Furcation involvement Class II or III Moderate ridge defect	In addition to stage III complexity: Need for complex rehabilitation due to: Masticatory dysfunction Secondary occlusal trauma (tooth mobility degree ≥2) Severe ridge defect Bite collapse, drifting, flaring Less than 20 remaining teeth (10 opposing pairs)
Extent and distribution	Add to stage as descriptor	For each stage, describe extent as localized (<30% of teeth involved), generalized, or molar/incisor pattern			

- for periodontal disease, the diagnosis is "gingivitis on a reduced periodontium in a stable-periodontitis patient." In a case with no treatment, the diagnosis is then "periodontitis."
- The similar process is also applied if the maximum PD is >3mm.When PD is >3 mm and BOP <10% without RBL or clinical AL, the diagnosis is "periodontal health." In a case with RBL/clinical AL and BOP <10%, PD = 4 mm with a history of periodontal treatment, the diagnosis is "health on a reduced periodontium in a stable-periodontitis patient." Usually, PD = 4 mm can still present in a periodontitis case that has been successfully treated· In a case with PD = 4 mm without history of periodontal treatment or PD ≥5 mm, the diagnosis is "periodontitis."
- However, when PD is ≥5 mm and even with BOP <10%, the case is still diagnosed as "periodontitis." In cases with PD >3 mm and BOP ≥10%, "gingivitis" will be assigned if there is no RBL/clinical AL, while "periodontitis" will be assigned in cases with RBL/clinical AL. Once a case is diagnosed with "periodontitis," a complete periodontal examination including full-mouth periodontal charting and radiographs as well as thorough history taking will be performed. The diagnosis can be confirmed with the case definition which is either

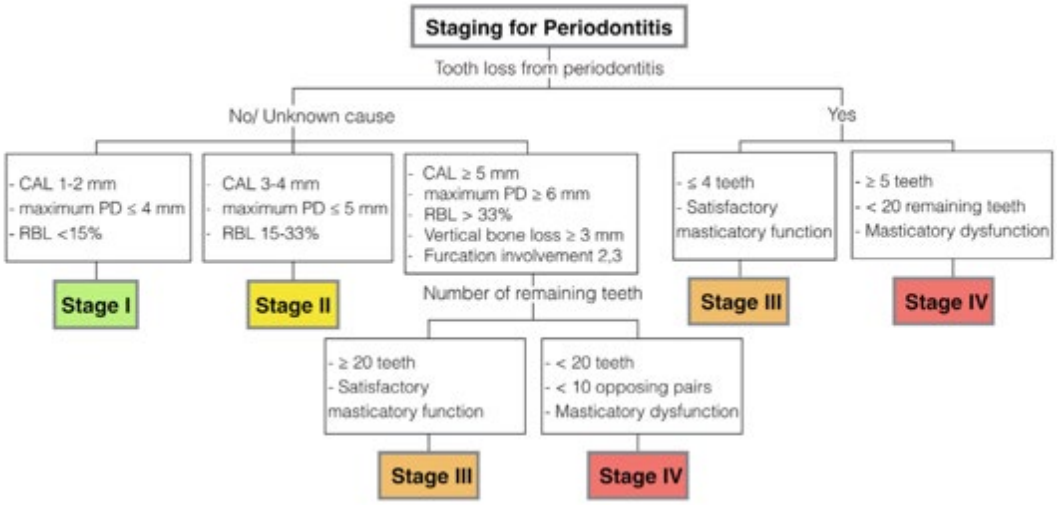
1) inter- dental clinical AL detectable at ≥2 non-adjacent teeth or

2) buccal, or oral clinical AL ≥3 mm with pocketing >3 mm detectable at ≥2 adjacent teeth. The observed clinical AL cannot be affected from non-periodontal causes. A specific form of periodontitis; periodontitis, necrotizing periodontitis, or periodontitis as a manifestation of systemic disease will then be identified. If the case has neither the characteristics of necrotizing periodontitis nor a rare systemic disease with a second manifestation of severe periodontitis, it will be diagnosed as "periodontitis."



Adapted form Chararkulangkun and Wang [24]

The second flowchart is proposed to identify the severity of periodontitis using the staging system. First, tooth loss from periodontitis, including teeth planned for extraction due to periodontitis as part of active therapy (e.g., hygienic phase) will need to be recorded. If tooth loss existed then the case is either stage III or IV. The differentiation of stage III or IV is based on the number of teeth lost and masticatory dysfunction. If the patient has tooth loss due to periodontitis of ≥5 teeth and/or <20 remaining teeth and/or need a rehabilitation because of masticatory dysfunction, periodontitis stage IV will be assigned. If there are <4 teeth lost due to periodontitis and no other masticatory dysfunction, then stage III is the diagnosis. If the patient does not have any tooth loss or has tooth loss from reasons other than periodontitis or unknown cause of tooth loss, a combination of clinical AL, PD, and RBL will be used to classify the patient. If the patient presents with clinical AL ≥5 mm and/or PD ≥6 mm and/or vertical bone loss ≥3 mm and/or furcation involvement grade 2 or 3, the case is either stage III or IV. As previously discussed, masticatory dysfunction and/or number of the remaining teeth will then be used to determine the stage. If clinical AL is <5 mm and/or PD <6 mm, stage I or II is assigned, based on clinical AL, the maximum PD, and the amount of bone loss.

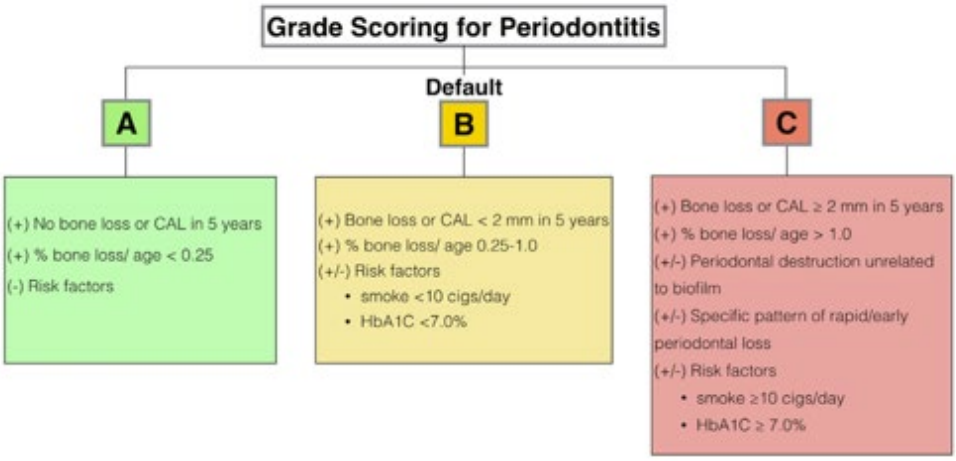


Adapted from Chararkulangkun and Wang [24]

The primary goal of grading is to determine which of two disease paths a specific patient is traveling on, and use this information to guide the most appropriate treatment strategy that will lead to successful outcomes. Finally, a periodontitis grade can be determined using the third flowchart Grade B is usually the default for most periodontitis cases and a clinician will consider if it should be adjusted to grade A or grade C. Evidence over recent decades supported that the majority of periodontitis patients are on a trajectory that will result in predictable clinical responses if standard principles of plaque control are applied diligently to the prevention and treatment of periodontitis . However, according to current estimates, ≈20% to 25% of our patients are on a different trajectory and, therefore, are less likely to respond predictably to standard approaches to managing periodontitis

Periodontitis grade			Grade A: Slow rate of progression	Grade B: Moderate rate of progression	Grade C: Rapid rate of progression
Primary criteria	Direct evidence of progression	Longitudinal data (radiographic bone loss or CAL)	Evidence of no loss over 5 years	<2 mm over 5 years	≥2 mm over 5 years
	Indirect evidence of progression	% Bone loss/age	<0.25	0.25 to 1.0	>1.0
		Case phenotype	Heavy biofilm deposits with low levels of destruction	Destruction commensurate with biofilm deposits	Destruction exceeds expectation given biofilm deposits; specific clinical patterns suggestive of periods of rapid progression and/or early onset disease (e.g. molar/incisor pattern; lack of expected response to standard bacterial control therapies)
Grade modifiers	Risk factors	Smoking	Non-smoker	Smoker < 10 cigarettes/day	Smoker ≥ 10 cigarettes/day
		Diabetes	Normoglycemic/no diagnosis of diabetes	HbA1c < 7.0% in patients with diabetes	HbA1c ≥ 7.0% in patients with diabetes
Risk of systemic impact of periodontitis	Inflammatory burden	High-sensitivity CRP (hsCRP)	<1 mg/L	1 to 3 mg/L	> 3 mg/L
Biomarkers	Indicators of CAL/bone loss	Saliva, gingival crevicular fluid, serum	?	?	?

Adapted form Chararkulangkun and Wang [24]



Natural History and disease progression

Periodontitis was previously believed to progress at a constant rate until treatment or tooth loss. For instance, individuals with so-called rapidly progressing periodontitis exhibited an annual rate of interproximal attachment loss of between 0.1 and 1.0 mm, while individuals with moderately progressing periodontitis exhibited a loss of between 0.05 and 0.5 mm.[25] Individuals with minimal to no progression exhibited an annual loss rate of between 0.05 and 0. 9 mm.[25] Currently, based on longitudinal observations from human and animal studies, periodontitis is now believed to progress by recurrent acute episodes instead. [26] During their lifetime, patients with periodontitis exhibit a cycle of bursts of destruction at individual sites over short periods of time, followed by longer periods of remission.[27]

With the addition of D. Basta we provide the following service			
Dental implants	**Dental implants**	**Periodontal treatment**	**Other**
Socket preservation	Immediate &delayed implant placement	Nonsurgical periodontal treatment	IV and oral sedation
Sinus elevation and ridge augmentation	Immediate & delayed temporary crowns for anterior implants	Surgical periodontal treatment Laser assisted New Attachment procedure (LANAP)	Impacted canine exposure
Pre-treatment consultation with you and your lab	Implants for fixed , hybrid or removable prostheses	Guided tissue regeneration for periodontal defects Gen 21, Emdogain	3D cone beam scans and analysis
We provide stock or custom scannable abutments and impression components	Treatment of peri- implant disease	Esthetic and functional crown lengthening	Frenectomy
Single or multiple implants	Digital treatment planing	Soft tissue grafting (autografts and allografts)	Biopsy and wisdom teeth extractions

Evidence-based treatment guidelines for periodontitis

The European Federation of Periodontology (EFP) has published the first formal evidence-based guidelines for treating periodontitis in a move that will help clinicians all over the world provide the best possible treatment for their patients. These guidelines offer oral-healthcare professionals precise therapeutic pathways based on individual patient diagnoses and makes recommendations on specific interventions to treat periodontitis. It provides evidence-based recommendations for therapy in relation to the first three stages of periodontitis, according to the new classification of periodontal and peri-implant diseases and conditions.

Step-by-step guidelines

The Guideline approaches the treatment of periodontitis stages I, II, and III using a preestablished stepwise approach to therapy that – depending on the disease stage – should be incremental, each including different interventions. An *essential prerequisite* to therapy is to inform the patient of the diagnosis, including causes of the condition, risk factors, treatment alternatives and expected risks and benefits including the option of no treatment.

Step 1 .	Step 2.	Step 3 .	Step 4.
The *first step in therapy* is aimed at guiding behaviour change by motivating the patient to undertake successful removal of supragingival dental biofilm and risk factor control	The *second step of therapy* (cause-related therapy) is aimed at controlling (reducing/eliminating) the subgingival biofilm and calculus (subgingival instrumentation).	The *third step of therapy* is aimed at treating those areas of the dentition non-responding adequately to the second step of therapy (presence of pockets ≥4 mm with bleeding on probing or presence of deep periodontal pockets [≥6 mm]), with the purpose of gaining further access to subgingival instrumentation, or aiming at regenerating or resecting those lesions that add complexity in the management of periodontitis (intra-bony and furcation lesions).	*Supportive periodontal care* is aimed at maintaining periodontal stability in all treated periodontitis patients combining preventive and therapeutic interventions defined in the first and second steps of therapy, depending on the gingival and periodontal status of the patient's dentition. This step should be rendered at regular intervals according to the patient's needs.

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Step 1 . Supragingival dental biofilm control (by the patient) Guiding behaviour change by motivating the patient to undertake successful removal of supragingival dental biofilm and risk-factor control.

Recommendation 1. What are the adequate oral hygiene practices of periodontitis patients in the different steps of periodontitis therapy?

The EPF recommends that the same guidance on oral hygiene practices to control gingival inflammation is enforced throughout all the steps of periodontal therapy including supportive periodontal care. Achieving adequate home care is an essential component of prevention of periodontal disease, successful periodontal therapy and long-term retention of the dentition. Clini ians should educate patients about the importance of effectively removing dental biofilm at home, especially prior to proceeding with active periodontal therapy . The importance of adequate home care should be reinforced frequently during the initial and subsequent phases of periodontal treatment. [28] Furthermore the supragingival professional mechanical plaque removal (PMPR) and control of retentive factors, is recommended as part of the first step of therapy.

Guiding behaviour change by motivating the patient to undertake successful removal of supragingival dental biofilm and risk-factor control.

Recommendation 1.1: **What are the adequate oral-hygiene practices of periodontitis patients in the different steps of periodontitis therapy?**
We recommend that the same guidance on oral-hygiene practices to control gingival inflammation is enforced throughout all the steps of periodontal therapy including supportive periodontal care.
· Supporting literature Van der Weijden and Slot (2015)

Recommendation 1.4: **What is the efficacy of supragingival professional mechanical plaque removal (PMPR) and control of retentive factors in periodontitis therapy?** We recommend supragingival professional mechanical plaque removal (PMPR) and control of retentive factors, as part of the first step of therapy. Supporting literature ;Needleman, Nibali, and Di Iorio (2015); Trombelli, Franceschetti, and Farina (2015)

Recommendation 1.6: **What is the efficacy of tobacco smoking cessation interventions in periodontal therapy?**
We recommend tobacco- smoking cessation interventions to be implemented in patients undergoing periodontal therapy. Supporting literature Ramseier et al. (2020)

Recommendation 1.7: **What is the efficacy of promotion of diabetes-control interventions in periodontal therapy?** We recommend diabetes- control interventions in patients undergoing periodontitis therapy. Supporting literature : Ramseier et al. (2020)

Recommendation 1.9: **What is the efficacy of dietary counselling in periodontal therapy?** We do not know whether dietary counselling may have a positive impact in periodontitis therapy. Supporting literature Ramseier et al. (2020)

Step 2 : Cause-related therapy, aimed at controlling (reducing/eliminating)the subgingival biofilm and calculus (subgingival instrumentation).

The second step of therapy (also known as cause-related therapy) is aimed at the elimination (reduction) of the subgingival biofilm and calculus and may be associated with removal of root surface (cementum We suggest that subgingival periodontal instrumentation can be performed with either traditional quadrant- wise or full- mouth delivery within 24 hours). The procedures aimed at these objectives have received in the scientific literature different names: subgingival debridement, subgingival scaling, root planning. Scaling and root planing should be performed at the sites with periodontal probing depths of 5 mm or greater. This phase of treatment should be delivered in conjunction with correction of local contributing factors, extraction of hopeless teeth and treatment of active carious lesions. During scaling and root planing, adequate local anaesthesia should be administered prior to initiating the procedure to ensure patient comfort. Automated instruments, such as piezoelectric or ultrasonic scalers, may be used in combination with manual instruments The establishment of infection control as measured by absence of clinical signs of inflammation and increased resistance to probing is the main goal of treatment, (reduction in pocket depth, both in terms of average measures as well as frequencies of *closed pockets* (probing pocket depth ≤ 4 mm and absence of bleeding on probing). Subgingival instrumentation is an efficacious treatment in reducing inflammation, probing pocket depth and number of diseased sites in patients affected by periodontitis. This effect was consistent, irrespective of the choice of instrument (sonic/ultrasonic vs. hand) or mode of delivery (full-mouth vs. quadrant). Thus, at shallow sites (4–6 mm), a mean reduction of PD of 1.5 mm can be expected at 6/8 months, while at deeper sites (≥7 mm) the mean PD reduction was estimated at 2.6 mm. [29] Hung et al.[30] in a comprehensive meta-analysis of nonsurgical treatment reported similar results as Cobb et al. for patients with chronic periodontitis. AT 4-6 mm probing depths, clinicians should expect a mean reduction in probing depth of about 1 mm and an average gain in CAL of approximately 0.5 mm . At deep sites probing depth > 7 mm, the probing depth reduction should average 2 mm and the gaining clinical attachment about 1 mm. The meta-analysis results showed that periodontal probing depth and gain of attachment level do not improve significantly following root planing and scaling for patients with shallow (<4 mm) initial periodontal probing depths. The decrease in the probing depth consists of two components : clinical attachment gain and recession . As a rule of the thumb clinicians can expect the gaining clinical attachment to be about half of the probing depth reduction

Initial probing depth	PD reduction	CAL gain
4-6 mm	1.29 mm	+0.55 mm
> 7mm	2.16 mm	+1.79 mm

An increase in the CAL (clinical attachment) refers to the new connective tissue attachment (new periodontal fibers inserting into the cementum) or the formation of a long junctional epithelium(repair) usually the latter occurs.

Efficacy of non-surgical therapy in deep pockets

Since successful non-surgical therapy is dependent on thorough root debridement , factors that influences the success need to be addresses . Several studies have reported on the limitation the closed scaling and root planing . Numerous studies have indicated that the predictability of subgingival calculus removal decreases as the probing depth increases [31-33]. Studies by Baderstein and coworkers using hand instruments ,found that the effectiveness of calculus removal is influenced by the initial pocket depth , tooth type and surface as well as the

operator experience [34-38]. The authors reported a higher percentage of calculus on root surfaces in pocket with probing depth of > 6 mm (up to 44%) compared to pockets with probing depth 4-5 mm (29 %) [31]

Waerhaug et al[33]. Evaluated the response to subgingival plaque removal on 84 teeth that were extracted after subgingival instrumentation. He reported that (90%) of the teeth had remnants of plaque on more than > 1 surface . Re-establishment of the dento-epithelial junction was possible if all the plaque was removed . According to the authors the DEJ was re-establish in 83% of < 3mm pockets, 39% of 3-5 mm pockets and only 11% of the time if pockets were >5 mm . Caffesse et al [32] evaluated SRP efficacy with and without surgical access. A correlation between the increased PD and residual calculus was found . Complete cleaning was possible 83% of the time in 1-3 mm pockets, 43% of the time in 4-6 mm pockets and 32% of the time in >7 mm pockets. Surgical access improved calculus removal in 4-6 and > 7 mm pockets. However, 24.3% of 4-6 mm pockets and 50% of > 7 mm pockets still had calculus after surgical access. Most of the residual calculus was found at the CEJ or in association with grooves fossae or furcations.

	Calculus free surfaces	Calculus free surfaces
Pocket depth	Closed	Open (flap surgery)
1-3 mm	86%	86%
4-5 mm	43%	76%
>6 mm	32%	50%

Thus, for areas with persistently deep periodontal probing depths (i.e. 6 mm or deeper), surgical periodontal therapy may be indicated. The significance of complete root debridement on arresting periodontal disease may be somewhat questioned by the improvement in the clinical parameters achieved by SRP in longitudinal studies Clinical trials of nonsurgical therapy have unequivocally shown that a biologically acceptable root surface is all that is necessary for successful periodontal treatment . Cobb et al suggested a calculus " critical mass " concept similar to that of plaque that is compatible with periodontal health . The alteration in the subgingival microflora from a disease associated subgingival flora to one associated with health is critical to the success of the non surgical periodontal therapy. Care should be taken not to conclude that complete debridement is not necessary , since studies have shown that al the teeth lost due to periodontal disease had heavy residual calculus deposits .

Are treatment outcomes of subgingival instrumentation better after use of hand, powered (sonic/ ultrasonic) instruments or a combination thereof?

The EPF recommends that subgingival periodontal instrumentation **is performed** with hand or powered (sonic/ultrasonic) instruments, either alone or in combination.

Are treatment outcomes of subgingival instrumentation better when delivered quadrant-wise over multiple visits or as a full mouth procedure (within 24 hr)?

The EFP **suggests** that subgingival periodontal instrumentation **can be performed** with either traditional quadrant-wise or full mouth delivery within 24 hr.

Adjunctive use of antibiotics

The adjunctive use of the systemic antibiotics for periodontal therapy has been discussed for many years . Most studies evaluated the systemic antibiotics in conjunction with non surgical periodontal therapy, the rationale for their use being the suppression of the periodontal pathogens persisting in the biofilms in deep pockets , root furcation and concavities and also residing within the periodontal tissues . In particular Recent clinical trials as well as systematic reviews reported a significant improvement in the outcome of scaling and root planning when antibiotics are used systemically as an adjunctive therapy . [39, 40] A recent meta analysis [40] reported a statistically significant additional full-mouth probing depth mean reduction of 0.488 mm and a clinical attachment level gain of 0.389 mm at 6 months follow up in the antibiotic versus the placebo control groups. These improvements were further supported by reductions in bleeding on probing and in frequency of residual periodontal pockets, and increases in periodontal pocket closure. There is increasing evidence that systemic antibiotics in the non-surgical treatment phase reduce the need and extent of surgery, and that minimally invasive secondary therapy – carried out in tissue free of infection – has better outcomes [41, 42] The most significant benefit was observed with amoxicillin and metronidazole. There is a great body of evidence to support the adjunctive use of some antibiotics in nonsurgical periodontal therapy. The main effect of this adjunctive benefit is observed in patients with deep pockets (pocket depth > 6 mm) or in patients diagnosed with aggressive type of periodontal disease . [43] To limit their overuse, we recommend abstention from using antibiotics whenever it is reasonable to assume that thorough non- surgical mechanical debridement alone can resolve the problem – and this is the case for uncomplicated and moderately advanced periodontitis. For a localised site with a deep periodontal pocket administration of the locally delivers antibiotic (minocycline microspheres may be considered .

Cause-related therapy, aimed at controlling (reducing/eliminating) the subgingival biofilm and calculus (subgingival instrumentation). ***Recommendation 2.3:*** **Are treatment outcomes of subgingival instrumentation better when delivered quadrant-wise over multiple visits or as a full-mouth procedure within 24 hours?**
We suggest that subgingival periodontal instrumentation caan be performed with either traditional quadrant- wise or full- mouth delivery within 24 hours. Supporting literature Suvan et al. (2019)

Recommendation 2.4: **Are treatment outcomes with adjunctive application of laser superior to non-surgical subgingival instrumentation alone?**

We suggest not to use lasers as adjuncts to subgingival instrumentation. Supporting literature Salvi et al. (2019)

Recommendation 2.7: **Does the adjunctive use of probiotics improve the clinical outcome of subgingival instrumentation?** We suggest not to use probiotics as an adjunct to subgingival instrumentation. Supporting literature Donos et al. (2019)

Recommendation 2.16: **Do adjunctive systemically administered antibiotics improve the clinical outcome of subgingival instrumentation?** Because of concerns about patient health and the impact of systemic-antibiotic use to public health, its routine use as adjunct to subgingival debridement in patients with periodontitis is not recommended. The adjunctive use of specific systemic antibiotics may be considered for specific patient categories (e.g. generalised periodontitis stage III in young adults). Supporting literature Teughels et al. (2020)

Re-evaluation after active therapy (scaling and root planning)

Re-evaluation should be conducted four to six weeks after completing scaling and root planing, A comprehensive periodontal charting should be updated and the findings compared to the initial charting to determine the degree of improvement. Furthermore, patient compliance, as determined by adherence to the suggested home care regimen, should be carefully evaluated. Generally, for areas with relatively shallow probing depths (i.e. 1–5 mm), non-surgical management, including repeated root planing if indicated, frequent periodontal maintenance therapy and continuous reinforcement of home care could be considered as a treatment approach. The efficiency of subgingival calculus removal decreases as the probing depth increase. Thus, for areas with persistently deep periodontal probing depths (i.e. 6 mm or deeper), surgical periodontal therapy may be indicated. It must be emphasised that excellent compliance with suggested home care is an indispensable pre-requisite for proceeding with surgical therapy in order to achieve the optimal surgical outcome Thus, if necessary, surgical therapy should be delayed until adequate biofilm removal is demonstrated by the patien.[28, 44, 45]

STEP 3 . Treating areas that do not respond adequately to the second step of therapy, to gain further access to subgingival instrumentation or aiming at regenerating or resecting lesions that add complexity to the management of periodontitis (intra-bony and furcation lesions)

In the presence of deep residual pockets (PPD ≥ 6 mm) in patients with stage III periodontitis after the first and second steps of periodontal therapy, we suggest performing access-flap surgery. In the presence of moderately deep residual pockets (4–5 mm), we suggest repeating subgingival instrumentation.

Periodontal surgical therapy

The treatment of Stage III periodontitis should be carried out in an incremental manner, first by achieving adequate patient's oral hygiene practices and risk factor control during the first step of therapy and then, during the second step of therapy by profes- sional elimination (reduction) of supra and subgingival biofilm and calculus, with or without adjunctive therapies. However, in periodontitis patients, the complete removal of subgingival biofilm and calculus at teeth with deep probing depths (≥6 mm) or complex anatomical surfaces (root concavities, furcations, infra bony pockets) may be difficult, and hence, the endpoints of therapy may not be achieved, and further treatment should be implemented. The individual response to the second step of therapy should be assessed after an adequate healing period (periodontal re-evaluation). If the endpoints of therapy (no periodontal pockets >4 mm with bleeding on probing or deep pockets [≥6 mm]) have not been achieved, the third step of therapy should be implemented. If the treatment has been successful in Areas with persistently deep probing depths generally exhibit underlying infrabony or vertical defects. Such teeth with infrabony or vertical defects exhibit significantly reduced survival compared to teeth without those defects Thus, for these teeth, osseous resective surgery may be considered. During this surgery, infrabony or vertical osseous defects should be reduced or eliminated by osteotomy and osteoplasty . Lindhe et al [46]introduced the concept of critical probing depth. It represents a baseline probing depth value: above which the outcome of the therapy will result in attachment gain, below which the outcome of the therapy will result in attachment loss

PD<2.9 mm	Supragingival therapy	Nonsurgical therapy (SRP) will result in CAL loss
PD-2.9-4.2mm		Nonsurgical therapy (SRP) will result in CAL Loss
PD>4.2mm-5.5mm	Surgery /nonsurgical treatment	Benefit form both surgical and nonsurgical therapy
PD>5.5 mm	Surgical treatment	Surgical periodontal treatment /conventional or LANAP

Treating areas that do not respond adequately to the second step of therapy, to gain further access to subgingival instrumentation or aiming at regenerating or resecting lesions that add complexity to the management of periodontitis (intra-bony and furcation lesions).

Recommendation 3.1: **How effective are access flaps compared to repeated subgingival instrumentation?** In the presence of deep residual pockets (PPD ≥ 6 mm) in patients with stage III periodontitis after the first and second steps of periodontal therapy, we suggest performing access-flap surgery. In the presence of moderately deep residual pockets (4–5 mm), we suggest repeating subgingival instrumentation. Supporting literature Sanz-Sanchez et al. (2020)

Recommendation 3.3: **What is the efficacy of pocket elimination/reduction surgery in comparison with access-flap surgery?**

In cases of deep (PPD ≥ 6 mm) residual pockets in patients with stage III periodontitis after an adequate second step of periodontal therapy, we suggest using resective periodontal surgery, yet considering the potential increase of gingival recession. Supporting literature Polak et al. (2020)

Recommendation 3.6: **Whatis the importance of adequate self-performed oral hygiene in the context of surgical periodontal treatment?**
We recommend not to perform periodontal (including implant) surgery in patients not achieving and maintaining adequate levels of self-performed oral hygiene.
· Supporting literature Expert opinion

Recommendation 3.10: **What is the adequate management of molars with class II and III furcation involvement and residual pockets?**

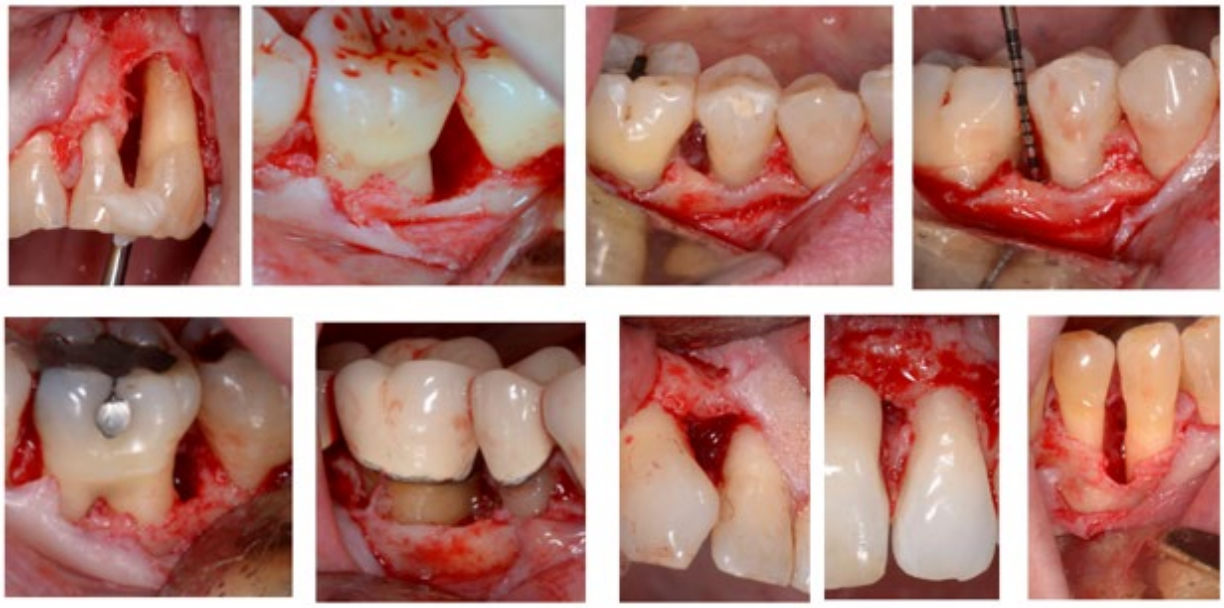
A. We recommend that molars with class II and III furcation involvement and residual pockets receive periodontal therapy. B. Furcation involvement is no reason for extraction.
· Supporting literature Dommisch et al. (2020), Jepsen et al. (2019)

Recommendation 3.11What is the adequate management of residual deep pockets associated with mandibular and or mandibular class II furcation involvement

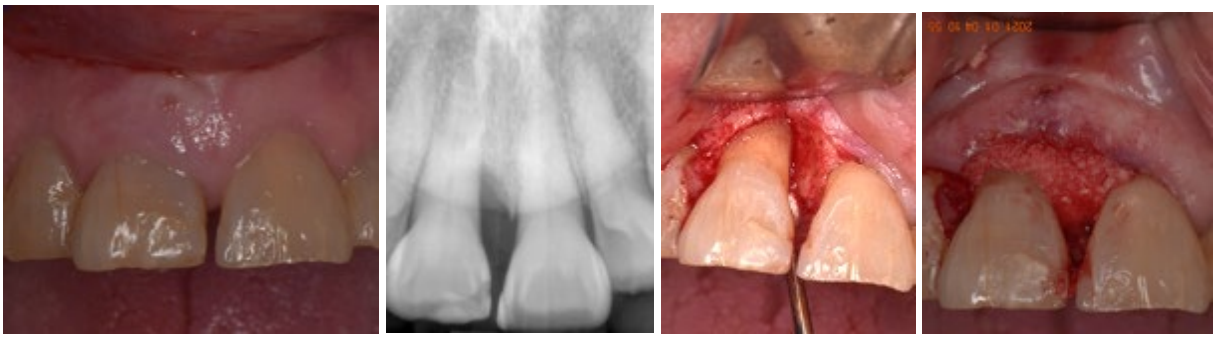
We recommend treating mandibular molar with class II furcation defect with periodontal regenerative surgery. In maxillary interdental Class II furcation involvement non-surgical instrumentation, OFD, periodontal regeneration, root separation or root resection **may be considered .** Supporting literature : Jepsen et al (2019) Dommisch et al. (2020); Huynh-Ba et al. (2009); Jepsen, Eberhard, Herrera, and Needleman, (2002)

Regenerative periodontal therapy

Regenerative periodontal surgery is intended to re- establish periodontal tissues lost as a result of the disease process. Specifically, the goal of this type of surgery is to increase attachment of the teeth to the periodontium and induce bone gain and increased support for the dentition [47] For infrabony or vertical defects, periodontal regenerative therapy should also be considered . Guided tissue regeneration utilises a barrier membrane with various particulate bone graft materials.[48-56]



Enamel matrix derivatives (EMD) have been used in periodontal regenerative therapy with the intent of inducing cell proliferation of both osteoblasts and periodontal ligament cells . [57, 58] A meta analysis reported that intrabony defects that were treated with EMD revealed a significantly greater clinical attachment gain compared to sites that were treated with open flap debridement[59] .



Recommendation 3.8 What is the adequate choice of regenerative biomaterials for promoting healing of residual deep pockets associated with a deep intrabony defect?

In regenerative therapy the EFP recommends the use of either barrier membranes or enamel matrix derivatives with or without the addition bone derived grafts
Supporting literature : Nibali 2019

Recommendation 3.9 what is the adequate choice for surgical flap design for the regenerative treatment of residual deep pockets associated with intrabony defect

We recommend the use of specific flap designs with maximum preservation of the interdental soft tissue such as papilla preservation flap .
Supporting literature : Nibali 2019 , Graziani 2012

Laser for periodontal disease

The use of lasers in dentistry, particularly in periodontics and peri-implant diseases, has grown since their introduction in the late 20th century. Lasers can be used either as an adjunct to conventional therapies or as a monotherapy replacing existing techniques – but they are not a magic wand that can change acceptable treatment concepts or cause miracles. Therapy using an Nd:YAG laser was reported to achieve periodontal regeneration. During this therapy, the laser is used to selectively remove the diseased inner sulcular epithelium, potentially exposing more of the diseased root surface. Following thorough root planing of the involved root surface, the laser is used again to create a stable blood clot . [60]

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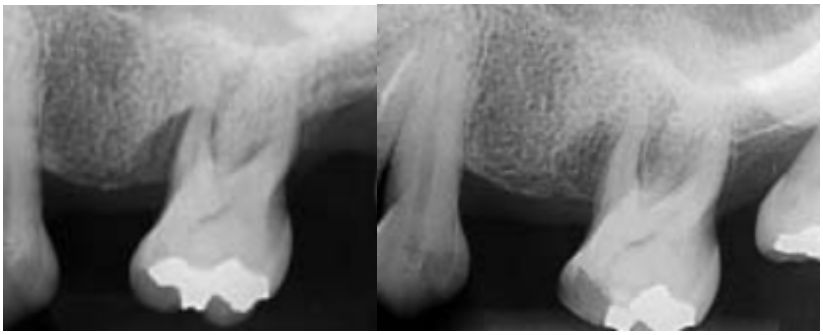

Adapted from Nevins et al .[60]

STEP 4 Supportive periodontal care, aimed at maintaining periodontal stability in all treated periodontitis patients, combining preventive and therapeutic interventions defined in the first and second steps of therapy, depending on the gingival and periodontal status of the patient's dentition

The EFP recommends that supportive periodontal care visits should be scheduled at intervals of 3 to a maximum of 12 months and ought to be tailored according to patient's risk profile and periodontal condition after active therapy.

PERIODONTAL MAINTENANCE THERAPY

For patients with a history of periodontal disease, periodontal maintenance should be provided on a regular and recurrent basis, generally at intervals of 2– 6 months[61]; however, the appropriate interval should be determined following completion of active periodontal therapy, and modified by continuously assessing an individual's risk for periodontitis[61] Among the factors to be considered are medical history (i.e. diagnosis of diabetes), smoking habit, presence of residual sites with deep probing depths, presence of other aforementioned contributing factors, and the level of home care A regular recall interval allows timely detection and intervention upon the recurrence or re-activation of disease in patients who have been previously treated for periodontitis. For example, compared to erratic and non-compliant patients, compliant patients who regularly attended periodontal maintenance therapy exhibited a significantly reduced tooth loss due to periodontitis[62]. During maintenance therapy, periodontal charting should be updated and radiographs obtained as needed. Furthermore, home care should be thoroughly reviewed. For areas with persistently deep or progressing periodontal probing depths, re-initiating active periodontal therapy (i.e. scaling and root planing, and surgical periodontal therapy) should be considered

Supportive periodontal care, aimed at maintaining periodontal stability in all treated periodontitis patients, combining preventive and therapeutic interventions defined in the first and second steps of therapy, depending on the gingival and periodontal status of the patient's dentition.

Recommendation 4.1: **At what intervals should supportive periodontal care visits be scheduled?**

We recommend that supportive periodontal care visits should be scheduled at intervals of 3 to a maximum of 12 months and ought to be tailored according to patient's risk profile and periodontal condition after active therapy.
· Supporting literature Polak et al. (2020), Ramseier et al. (2019), Sanz et al. (2015), Trombelli et al. (2020), Trombelli et al. (2015)

Recommendation 4.7: **What is the value of dental flossing for interdental cleaning in periodontal maintenance patients?**
We do not suggest flossing as the first choice for interdental cleaning in periodontal maintenance patients.
· Supporting literature Slot et al. (2020)

Recommendation/statement 4.11: **Should adjunctive chemotherapeutics be recommended for patients in supportive periodontal care?** A. The use of adjunctive antisepticsmay be considered in periodontitis patients in supportive periodontal care in helping to control gingival inflammation, in specific cases.
B. We do not know whether other adjunctive agents (such as probiotics, prebiotics, anti- inflammatory agents, antioxidant micronutrients) are effective in controlling gingival inflammation in patients in supportive periodontal care.
· Supporting literature Figuero, Roldan et al. (2019)

Recommendation/statement 4.20: **What is the role of physical exercise (activity), dietary counselling, or lifestyle modifications aiming at weight loss in supportive periodontal care?**

We do not know whether physical exercise (activity), dietary counselling or lifestyle modifications aiming at weight loss are relevant in supportive periodontal care.

· Supporting literature Ramseier et al. (2020)

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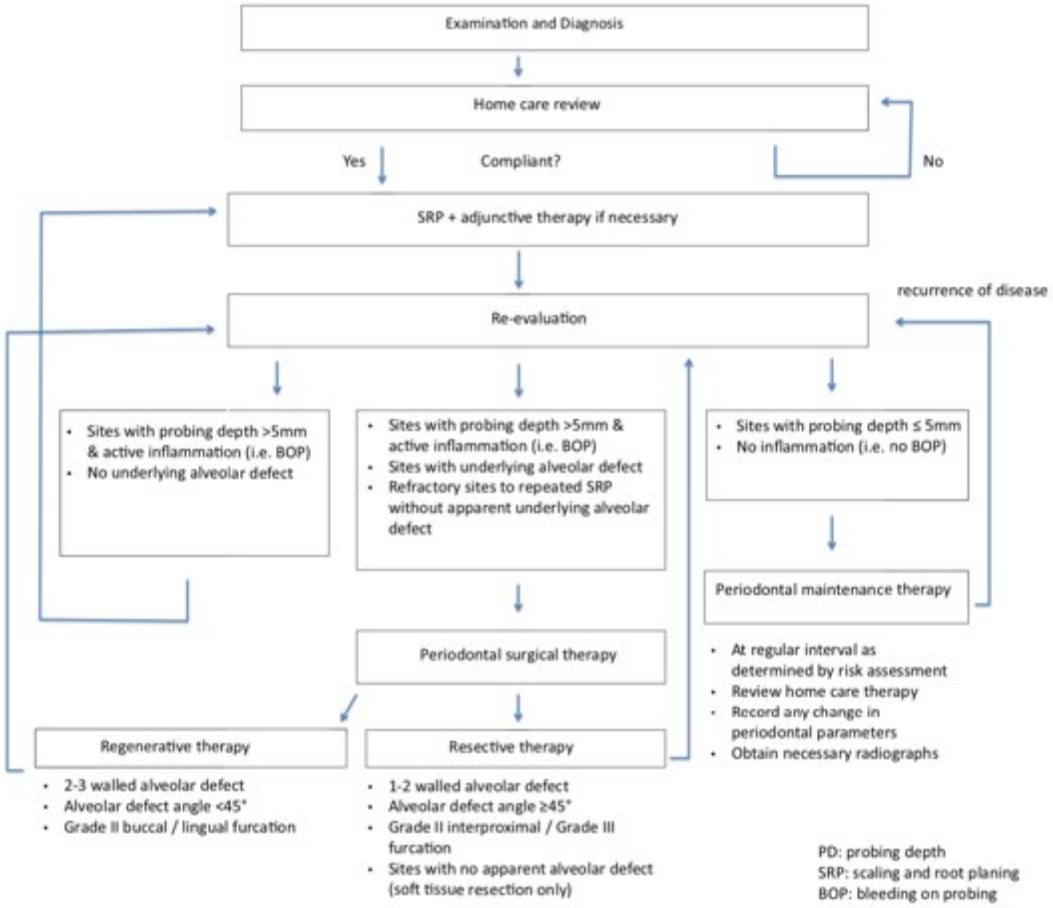
DECISION TREE AND CURRENT TRENDS

A decision tree representing the management of a patient with periodontitis can be helpful in recognising that the goals of periodontal therapy include not only the arrest of periodontitis but when feasible the regeneration of periodontium lost as a result of disease[63] Traditional resective periodontal surgery offers reliable methods to access root surfaces, reduce periodontal probing depths and attain improved periodontal architecture. However, these procedures offer only limited potential towards recovering tissues destroyed during earlier active disease[63]The introduction of new biological modifiers and new approaches to successful periodontal regeneration indicates a trend favouring conservative surgical therapy [63] This represents a fundamental shift in the intent of periodontal surgery, away from tissue removal to an approach that maintains existing periodontium and seeks to re-establish support that was lost. With the introduction of dental implants, a natural tooth with a compromised periodontal prognosis may be extracted and replaced with a dental implant instead of receiving periodontal therapy. However, while implant retention is high (at least 90% after 5 years), a meta-analysis of a total of 6,283 implants estimated the frequency of peri-implant mucositis and peri-implantitis as 30.7% and 9.6%, respectively, indicating that implant therapy is not without complications[64]. Furthermore, peri-implantitis and periodontitis appeared to share common risk factors such as poor oral hygiene, smoking and diabetes[64, 65]. The previous history of periodontitis as well as having a residual site with a periodontal depth of 6 mm or more were also associated with greater odds for developing peri-implantitis[66] Thus, the premature and strategic removal of a tooth with periodontitis for the sake of delivering implant therapy should be avoided In addition, when considering extraction of a tooth due to periodontitis and subsequent replacement with a dental implant, clinicians should inform patients regarding the potential risk of developing peri-implantitis, which may ultimately result in implant failure[67]

DECISION TREE FOR TREATING PATIENTS WITH

Adapted from Kwon and Levin[5]



CONCLUSIONS :

CAREFULL diagnosis, elimination of the causes and reduction of the modifiable factors are of paramount importance in the prevention and successful treatment of periodontal disease. According to our current knowledge and long term treatment of chronic periodontal disease a guideline for the decision-making process involving different types of periodontal therapy s recommended. SRP, surgical resective or regenerative periodontal therapy and antibiotic treatment are available therapeutic modalities that should be used in different combinations for the individual patients and/or sites as needed to achieve successful periodontal treatment.

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Further information will be mailed to you in the coming month with the date and location.

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