Hanoverian prevention concept to improve (self-responsible) home-based oral hygiene

Caries and periodontitis are biofilm associated diseases with multifactorial causes. In addition to regular visits to the dentist and dietary control, the efficient removal of oral biofilm plays a major role in the prevention of these diseases. The removal of biofilm should not only be the concern of the dental professional, but rather that of the patient who should routinely employ home-based oral hygiene measures [10]. Therefore, self-responsible, home-based oral hygiene is an important pillar for maintaining oral health.

The awareness with regard to oral health of the German population has increased significantly in recent years. In the Fifth German Oral Health Study (DMS V), depending on the age group, between 70–85 % of the survey respondents were convinced that they could contribute "very much" or "much" to maintaining or improving their oral health [23]. Thus, patients are certainly aware of the fact that plaque/biofilm removal as part of self-responsible, home-based oral hygiene is of great importance in the prevention of caries and periodontitis. Especially in the age group of young seniors (65 to 74-year-olds), a significantly increased awareness of their own oral health was observed in DMS V [23]. However, DMS V also shows that a relatively large number of patients are still affected by caries (particularly root and crown margin caries) and inflammatory periodontal disease. Nowadays, successful prevention concepts combined with advances in the field of restorative dentistry have made it possible to preserve natural teeth for much longer or even until the end of life [26]. Hence, there is a clear trend towards "tooth preservation in old age" (significant reduction in tooth loss) [23]. However, the longer that teeth are preserved, the more they are exposed to the risk of periodontitis or caries. The causes of increased susceptibility to root or crown margin caries in older people is multifactorial (e.g. increased proportion of exposed root surfaces or crown margins, extensive prosthetic restorations, insufficient removal of plaque, reduced salivation [caused by medication], previous periodontal therapies) [1, 7, 20, 29].

In relation to periodontal health, DMS V shows that 75.4 % of younger seniors (65 to 74-year-olds) suffer from moderately severe (one in two; 50.8 %) or severe periodontitis (one in four; 24.6 %) and that 80.6 % of older seniors (75 to 100-year-olds) suffer from moderately severe (one in two; 50.5 %) or severe periodontitis (one in three; 30.1 %), thus suggesting that periodontitis is still widespread [23]. Given that periodontitis increases with age, the demographic trend implies that the need for treatment should be expected to increase in the future.

Meanwhile, ample evidence from epidemiological, clinical and experimental studies has suggested that periodontal infections are not only influenced by systemic factors, but that they themselves can also exert systemic effects [24]. Oral health, which can be defined as the unrestricted functionality and symptom free from inflammation and discomfort, is an important component of general health together with a healthy diet and it has a close link to the quality of life [8, 36]. The saying "health begins in the mouth" is indeed true when a well functioning and well maintained masticatory system is present. The effectiveness of a good home-based oral hygiene combined with regular prophylactic visits to the dental professional for the prevention of caries and periodontitis has been proven in studies [2, 6]. The sole removal of biofilm by qualified dental personnel in the context of professional tooth cleaning is not sufficient for the prevention of caries and periodontitis. Rather, it should be regarded as an individual prophylactic component in a more comprehensive prophylaxis concept [38]. In addition to needs-based plaque removal, a thorough prophylaxis concept should also focus on teaching practical skills for optimal home-based oral hygiene, as well as, foster

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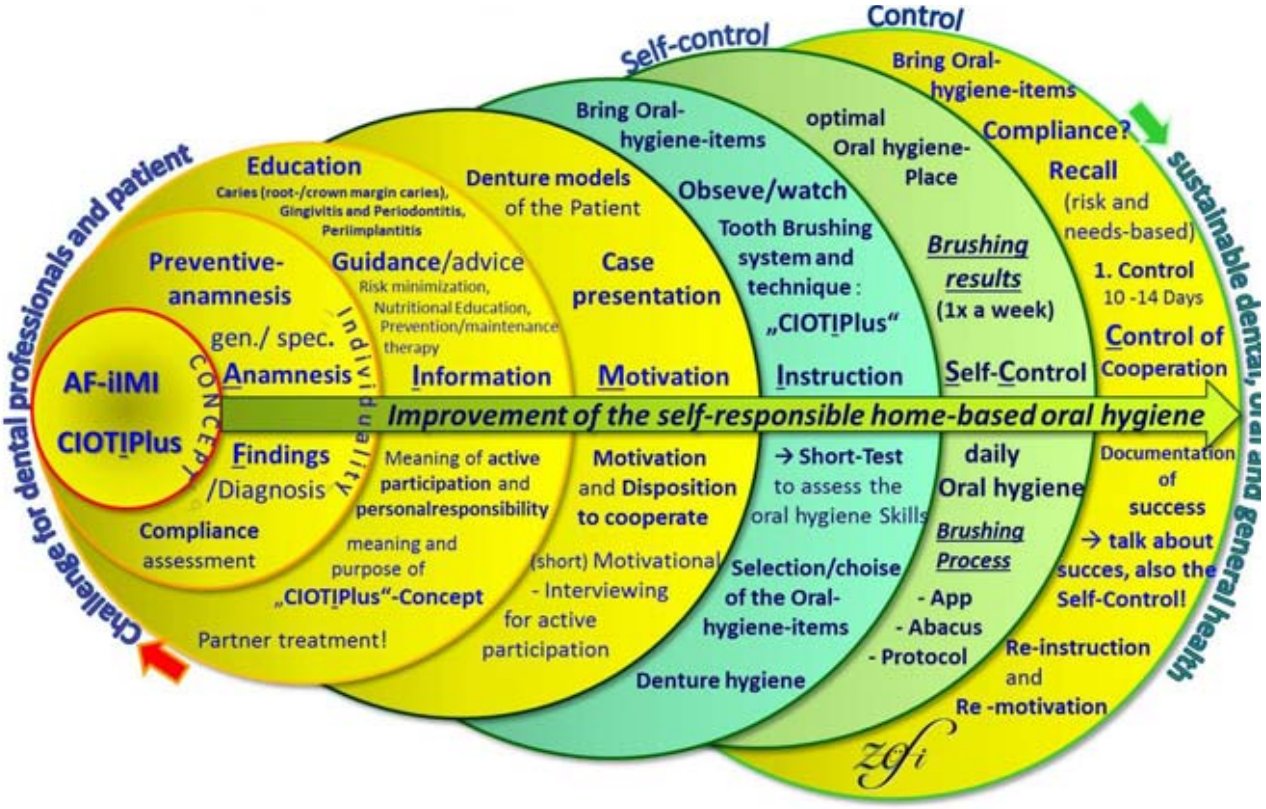


Figure 1 Hanoverian prevention concept to improve self-responsible, home-based dental and oral hygiene

health-promoting and health-preserving behavior patterns through education, instruction and motivation [30].

At the Clinic for Conservative Dentistry, Periodontology and Preventive Dentistry in Hannover, we have developed a practicable prophylaxis concept which consists of different interlinking and overlapping components: "anamnesis and findings – individual information, motivation and instruction (**AF-iIMI**)", "the **CIOTIPlus** tooth brushing system and technique", "**self-control of oral hygiene**" and "**compliance assessment**" (Fig. 1). The effectiveness of each individual component has already been investigated and confirmed in several studies and pilot projects [13–18, 25]. The combination and integration of each component into an overall concept should lead to an improvement in self-responsible, home-based oral hygiene and oral hygiene self-control, specially in risk groups, hence ensuring sustainable dental, oral and general health. Each components of the Hanoverian prevention concept are presented below.

Components of the Hanoverian prevention concept

AF-iIMI (**a**namnesis, **f**indings, **i**ndividual **i**nformation, **m**otivation and **i**nstruction) is the main component of the prophylaxis concept. However, it should not only be understood as pure oral hygiene training.

A

In the beginning, a general, specific and prevention **anamnesis** (including dietary anamnesis) is recorded. On the one hand, this allows conclusions to be drawn regarding compliance (health awareness and behavior, individual significance of oral hygiene, motivation for change), while on the other hand, it also provides clues as to whether interdisciplinary cooperation is needed as part of **o**ral **h**ealth **c**are **p**romotion **i**nterdisciplinary (OHCP-i) (e.g. cooperation with diabetologists, general physicians, family physicians).

F

After this, in order to evaluate the risk, determine the need for treatment and establish the current level of oral hygiene, oral (tooth, implant, periodontal, peri-implant and mucosa) **findings** and quantitative plaque indices for the smooth and proximal surfaces of teeth are collected. The degree of gingival inflammation is checked using the index "Bleeding on Probing" (BoP) and the need for periodontal treatment is determined using the "Periodontal Screening Index" (PSI). The *bleeding* and *plaque indices* are suitable for quantifying and monitoring the current *oral hygiene status* of the patient. For better visualization, plaque staining agents are applied to make plaque visible for the patient, while keeping in mind to differentiate between "old" and "new" plaque. The results of a plaque index, where only a yes or no decision is made with regard to the presence of plaque, is often less suitable for motivating the patient than an index that assesses plaque quantitatively (e.g. Quigley-Hein-Index – QHI). Hardly any patient is able to achieve complete plaque free within the framework of home-based oral

Figure 2 Using a magnifying mirror, problem areas are revealed to an 89-year-old female patient based on the AF-iIMI framework

Figure 3 Education regarding AF-iIMI of the same patient

hygiene. The value of a plaque index with a simple qualitative yes or no decision may change only marginally in the course of follow-up examinations, despite a significantly reduced amount of plaque. Therefore, this type of index does not track changes in plaque levels thoroughly enough and could result in patient demotivation. Similar to the QHI, which assesses the extent of plaque on smooth surfaces, we have suggested an index to assess the extent of plaque in approximal areas (mAPI) [15]. Under optimal lighting conditions and with the help of magnifying mirrors, the patient is shown "problem or weak areas" in the mouth (Fig. 2). Individual denture models or intraoral images of the patient's mouth can also be helpful here. The presentation of the patient's specific case using, for example, X-rays, photos (not only current, but also previous ones, if available) as part of a "case presentation" individualizes the possibly existing problem and should act to sensitize the patient with regard to his/her dental and oral hygiene and self-responsibility. For patients with removable dentures, a demonstration is necessary to point out any existing plaque on the denture, as denture hygiene is also a component of dental and oral hygiene.

iI

Based on the anamnesis and findings, each patient receives **individualized** needs-oriented education and **information** regarding, for example, caries (root surfaces and crown margins), gingivitis, periodontitis and peri-implantitis, as well as advice on possibilites of risk minimization, prevention, treatment and maintenance therapy (recall). Supplementary dietary recommendations for (dental) health should also include advice on foods that promote and inhibit inflammation. Moreover, the function of mastication and the necessity of intensive chewing needs to be explained (Fig. 3). When periodontal treatment is required, it is essential that the patient understands the meaning and purpose of "partner treatment". In this step, the relevance of being "self-responsible" and active participation for his/her dental and oral health should also be clarified. Furthermore, the effect of regular and effective home-based dental and oral hygiene on oral health should also be explained while not forgetting to emphasize the importance of employing a systematic approach (e.g. the CIOTIPlus system or technique).

M

An important prerequisite for subsequent **motivation** is to first determine the extent to which the patient can be motivated and is willing to cooperate. Depending on the patient, different models (e.g. the preventive intervention or transtheoretical models) can be used for support. Based on the categorization of the patient, *individualized motivation* then follows, which should include the principles of "motivational interviewing" (MI) for active participation. In order to make this session strictly individualized for the patient, the motivational interview should make use of aids in the form of denture models of the patient, X-rays, photographs and the documented findings of the plaque and inflammation indices which present the patient's own case. If the need for treatment was identified at the time of diagnosis, it is vital that the patient is first given a "*whole mouth therapy concept*" before following any further instructions on oral hygiene measures; this is done in order to minimize iatrogenic irritation factors and establish hygiene ability. It is imperative to avoid standardized, ordinary, and boring routine explanations when familiarizing patients with the AF-iIMI approach! The patient must have the feeling of receiving personalized individually care! It is recommended not to resort to any repetition of well-known slogans (e.g. "Don't forget to brush your

teeth twice daily after meals!") in preventive care, as only individualized health counseling can shape health-conscious behavior [19]. In order to ensure consistent professional thinking using the same language, the dental professional and the office staff must discuss the office's prophylaxis concept as a team and update it regularly with new findings (very important: joint continuous internal and external training). Motivational Interviewing (MI) is another evidence-based method for positively influencing patient behavior in dentistry [37]. Based on the "preventive intervention model" according to Weinstein et al. (1989), the patient's perception of risk ("recognizing having a problem") and willingness to cooperate (willingness to work on the problem) are the basic prerequisites for successful prophylaxis [35]. The reasons for failure in the area of motivation and instruction usually have 3 different causes: lack of knowledge, lack of skills or lack of motivation. A thorough behavioral analysis before starting motivation and instruction should therefore establish whether the problems are connected to knowledge, skill or motivation. Accordingly, in several small steps, either knowledge can be imparted (for problems on the knowledge level), skills can be trained (for problems on the skill level) or work can be done on problems with motivation [11]. In any case, the patient must be aware of their own responsibility. In order to successfully motivate a patient, his/her willingness to cooperate should be assessed in advance. Although originating from health psychology, a classification using the "transtheoretical model" can also be of help in dentistry [9].

Figure 4a Observation of a 71-year-old patient through a venetian mirror in a special oral hygiene place while she performs oral hygiene in the context of AF-iIMI

Figure 4b Observation-oriented oral hygiene instruction using a model for the same patient at a special oral hygiene place within the context of AF-iIMI

I

As part of **instructions**, the patient should first demonstrate how he/she performs home-based oral hygiene with his/her personal *oral hygiene tools* brought from home. Beforehand, the plaque should be made visible to the patient with a plaque staining agent. Instructions must be observation-oriented (Fig. 4a and b) and dependent on individual abilities as well as the intraoral status of the patient. It is advisable to perform this step together with the patient in special oral hygiene places with "bathroom-like equipment" (mirror, washbasin, magnifying mirror with a light source, opportunity to sit). The patient is asked to demonstrate his/her daily dental and oral hygiene routine with own oral hygiene tools brought from home. Firstly, it should

be evaluated if the tools already being used by the patient allow for sufficient oral hygiene or whether small changes in the application of these tools could lead to hygiene improvement. Depending on the individual abilities and motivation of the patient, various other oral hygiene tools can be recommended and training with them should occur on site with the patient. Oral hygiene recommendations for older people, in particular, should be formulated as simple as possible and tailored to their individual abilities and motivation, while simultaneously paying particular attention to possible age-related functional limitations such as a decline in motor, sensory or mental abilities [36]. In order to objectively verify the motor, sensory and mental abilities of a patient, various "*short tests*" can be used (e.g. the money counting test and the neck grip left/right, and if necessary, the fist/fingertip test) [31]. The results of the various tests can then be used to decide which oral hygiene tools (hand and electric toothbrushes [oscillating/rotating or sonic]) can be used for home-based oral hygiene. Often, "modifications" of oral hygiene tools can be useful. For example, if patients are no longer able to grip or guide a manual toothbrush properly, an individualized "gripping aid" for the toothbrush handle may help them. Changing to an electric toothbrush, which has a more compact and easier to grip handle, and which also requires no movements from the wrist joint, may also be beneficial. In case of decreased eyesight we recommend wearing reading glasses during oral hygiene and using a magnifying mirror with an integrated light source. An opportunity for seating gives the patient the chance to take sufficient time for oral hygiene.

For patients with removable dentures, advice regarding the importance of regular and effective denture hygiene for oral health should not be overlooked. The plaque (biofilm) on removable dentures represents a source of microorganisms. Therefore, careful cleaning and, if necessary, disinfection of the dentures is as important as brushing natural teeth and implants. The tools and procedure for cleaning the dentures should also be shown and explained.

Many dental professionals recommend the "modified bass technique" for mechanical plaque removal using a toothbrush [5]. However, this technique is difficult to learn. There is no evidence in literature indicating that this technique is superior to, for example, the "horizontal scrubbing technique" for plaque removal [12, 27, 34]. It is generally agreed that it is probably more important to follow a brushing system than to follow a specific technique when using both hand and electric toothbrushes [12]. The regular use of a certain system is intended to prevent teeth or tooth surfaces from being overlooked during home-based oral hygiene [28]. For this reason, we recommend, explain and demonstrate the "CIOTIPlus" system and technique to the patient as part of the instructions [16]. According to this system, the patient first brushes the **c**hewing, followed by the **i**nside and **o**utside surfaces, with a toothbrush. Afterwards, the **t**ongue and **i**nterdental spaces are cleaned with interdental hygiene tools. Subsequent to this cleaning procedure, the patient re-applies the same pea-sized amount of fluoride-containing toothpaste evenly across all tooth surfaces and uses the toothbrush to systematically brush the tooth surfaces and gums using circular or rotating movements ("**plus**"). In order to clearly demonstrate the advantage of the system's "plus" step to the patient, it is useful to make the plaque visible again before and after the "plus" step. The plaque is made visible to the patient a total of 3 times: before the instruction, after performing the "CIOTI" system and after the "plus" step. In this manner, the patient can see and be convinced that a further reduction of plaque can be achieved by the "plus" step. This system does not literally denote "double" brushing, as the entire cleaning process is not repeated in the same way [16]. By applying the fluoride-containing toothpaste once more, the tooth surfaces are mechanically cleaned again on the one hand, while on the other hand, additional fluoride administration occurs. Fluoride appears to be more effective on clean, plaque-free tooth hard tissue [22]. The aim of "CIOTIPlus" system is to achieve both a more effective plaque reduction (removal of supragingival [visible] and achievable subgingival [non-visible] plaque from the tooth surface) and improved fluoride availability to the tooth surface. In addition, the periodontium is also stimulated by mechanical stimuli (plus function), which is intended to promote blood flow to the epithelium and subepithelial connective tissue and to strengthen the periodontal tissue. The effectiveness of CIOTIPlus has already been proven in several studies [13, 15, 17, 25]. In older patients that had undergone periodontal therapy, the use of the CIOTIPlus system not only increased the removal of plaque on smooth and proximal surfaces [13, 15, 17, 25], but combined with efficient regular supportive periodontitis therapy, it even minimized the formation of new root surface and crown margin caries and stabilized or improved the periodontal conditions [15]. Yet, in order to identify "problem sites" in the area of plaque control, and thus successfully prevent caries and periodontal disease, individualized and observation-oriented dental and oral hygiene advice, information and instruction (AF-iIMI), as well as regular re-instruction and re-motivation are absolutely essential for every patient. Following the oral hygiene training, a professional tooth cleaning is performed.

SC

In order to achieve the best possible results in self-responsible, home-based oral hygiene, a patient should be able to evaluate and control the cleaning process and cleaning result alone.

Self-control of the cleaning process (daily):

It appears that many patients have difficulties with the regular implementation of a specific daily dental and oral hygiene system. Numerous possibilities exist for patients to perform the self-control of the cleaning process or system. In the digital age, computer programs or apps may offer the possibility to support patients in their daily dental and oral care [21]. However, the fact that

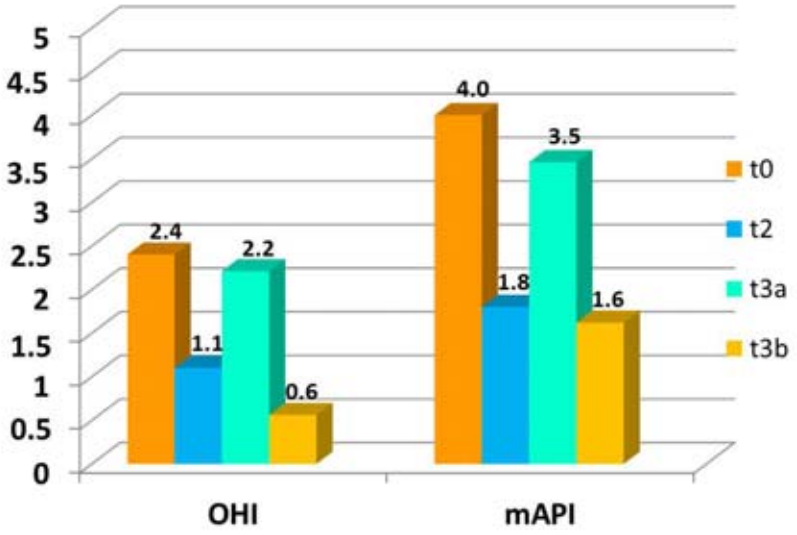
Figure 5a 72-year-old patient, condition before the start of AF-iIMI

Figure 5b The same patient, status before the start of AF-iIMI, plaque made visible with a plaque-staining agent (t0) (QHI: 2.4; mAPI: 4.0)

Figure 5c The same patient, status 3 weeks after AF-iIMI, plaque made visible with a plaque-staining agent (t2) (QHI: 1.1; mAPI: 1.8)

Figure 5d The same patient, status 6 months after AF-iIMI, plaque made visible with a plaque staining agent (t3a) (QHI: 2.2; mAPI: 3.5)

Figure 5e The same patient, status 3 weeks after Fig. 5d, plaque made visible with a plaque-staining agent (t3b) (QHI: 0.6; mAPI: 1.6)



(Fig. 1–5: H. Günay & K. Meyer-Wübbold)

Figure 5f Smooth and proximal surface plaque index values of the 72-year-old patient at different times

computer programs or apps are not suitable for everybody should be considered. Particularly, many older people use newer technical devices less than younger ones. The reasons for this are manifold. First, older people barely have any contact with new technologies because they did not grow up with them and thus lack an understanding of how modern technology works [31, 32]. Moreover, physical challenges occurring in older age, such as visual or hearing impairments, limitations in fine motor skills and cognitive limitations, can also be a hurdle [31, 32]. In a survey, 41 % from 1000 people over the age of 65 stated that they found it difficult to operate modern technical devices [31, 32]. In order that these patients also have the possibility to self-control their oral hygiene at home, our working group "oral health care promotion" has developed an initial "oral hygiene protocol" in which the patient can document the system he/she has used on a daily basis. We evaluated the use of these protocols in a study and it could be shown that such protocols are well suited for the self-monitoring of the cleaning process for a short period of time and that they do indeed improve oral hygiene [15]. However, such simple protocols are frequently not very attractive for patients in the long run. Thus, we have additionally developed an abacus ("CIOTIPlus-Abacus"). With this tool, it is very easy for the patient to document the "CIOTIPlus" brushing system and technique on a daily basis in a playful way, which also increases the motivation to use this tool for documentation and self-control. At the same time, this tool allows the patient to test his/her cognitive and motor skills. Unfortunately, the success of the tool was not evaluated over a longer time period and this is why we developed an app/computer program. The use of the CIOTIPlus-App and the CIOTIPlus-Abacus were tested in a pilot study; it was shown that dental and oral hygiene could be significantly improved by self-controlling the cleaning process with an app or abacus in senior citizens [18].

Self-monitoring of the cleaning result (once weekly):

Many patients find it difficult to objectively evaluate their own cleaning result. A pure visual check, even with magnifying aids and optimal lighting conditions or a "tongue feel test" to identify any plaque-affected areas that may still be present is insuffi-

cient and cannot reveal hidden "problem or weak areas" (e.g. interdental spaces, the inside surfaces of the teeth and the areas around the gum line) particularly well. We therefore recommend that patients use plaque staining agents (e.g. staining [chewing] tablets or rinsing solution) at least once weekly during their home dental and oral hygiene in order to visualize plaque. Plaque staining agents that make a distinction between "new" and "old" plaque are also useful. Patients should make plaque visible both before starting and after completing home-based oral hygiene. The initial staining serves as a guide for performing oral hygiene by allowing one to concentrate directly on the "problem or weak areas". The second staining is then used to check the cleaning result. Studies have shown that a second staining after tooth brushing is advisable; the plaque staining agents in any remaining plaque are partially washed out or bleached by the cleaning process and the ingredients in toothpaste (e.g. surfactants), thus making plaque less visible to the patient [13]. Visualization of plaque helps patients to evaluate and optimize their own oral hygiene [3, 4]. Before recommending that the patient self-monitors the cleaning result, however, it is necessary to demonstrate and explain to the patient from the perspective of the dentist how the "coloring agents" are used and which spatial requirements or additional tools (e.g. mouth mirror, telescope magnifying mirror with light source) are necessary for doing this. The self-monitoring of cleaning results by visualizing plaque gives patients the chance to recognize their own problems and weaknesses, and thus, to continuously improve their cleaning system or technique! Most patients falsely appraise their own oral hygiene as being considerably better in the absence of plaque visualization [18]. Patients' self-evaluation after the demonstration of plaque staining correlated well with the objective findings of the plaque indices.

The patient should therefore be made conscious of the need for self-control of oral hygiene at home. First of all, the necessary home conditions should be discussed (optimization of the site for home-based oral hygiene by means a telescope magnifying mirror with a light source and possible seating).

C

All good intentions fade with time. In this respect, success in terms of patient **cooperation** is rather short-term [4]. Figures 5a–f illustrate a patient case. The patient was re-examined 3 weeks after "AF-iIMi" and a clear improvement in home-based dental and oral hygiene was observed based on the smooth and proximal surface plaque index values. After 6 months, the same patient was re-examined again. However, the plaque index values of the smooth and proximal surfaces were found to have returned to the initial values. In order to successfully prevent caries and periodontal disease in the long-term, in addition to the AB-iIMI (including implementation of the system/technique CIOTIPlus) and self-control in home-based oral hygiene, patient cooperation should be regularly monitored in terms of re-instruction and re-motivation. It is advisable to schedule the patient for a (success) **control** 10–14 days after the first AF-iIMI in order to clarify possible questions, to control if the given recommendations for home dental and oral hygiene were fulfilled and to re-instruct and re-motivate the patient. During recall sessions, the patient is again shown possible weak and problem areas related to his/her home-based oral hygiene. However, caution should be exercised in order to avoid demotivating the patient.

In this appointment, the patient is once again asked to bring his/her own oral hygiene tools and an objective evaluation can be made based on plaque and inflammation indices. During the appointment, the next recall appointments should then be scheduled needs-based (risk-oriented). Depending on the patient's needs, ¼-, ⅓- or ½-yearly intervals are chosen. The recall appointment procedure is also individualized and needs-oriented and includes all the elements of the concept.

Conclusion

The improvement of home-based oral hygiene for risk groups is a challenge both for the dental professionals and teams as well as for the patient. The presented concept can help to contribute to sustainable dental, oral and general health in these groups.

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