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Prevention in Orthodontology – a Practice Concept

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Quintessence for the practice team

Successful prevention during orthodontic treatment is a special challenge for patients and practice teams. Both home as well as professional oral hygiene are more difficult. Removable and fixed appliances in particular are associated with increased biofilm retention. This leads to a higher risk of oral diseases (caries, gingivitis and periodontitis). The practice team must meet these increased demands with well-organized and perfect biofilm management, in which case oral diseases can be largely avoided during orthodontic treatment.

Introduction

Over the past decades, orthodontic treatment has increased in western industrialized countries (1). Based on self-reported data from the second follow-up survey of the Study on the Health of Children and Adolescents in Germany (KiGGS) (2), the demand for orthodontic treatment was investigated. Overall, 25.8% of girls and 21.1% of boys aged 3 to 17 years are receiving orthodontic treatment.

Utilization is very much age-dependent. It is highest among girls aged 13 (55.0%) and boys aged 14 (50.8%). Compared with data from previous KiGGS surveys, the trend over approximately ten years shows a significant increase in orthodontic care across all age groups (2). At over 60%, the treatment of adolescents with orthodontic interventions in Germany's statutory health insurance system (GKV) exceeds all international norm values, which range between 12.5% and 45%.

Successfully completed orthodontic treatment can greatly facilitate oral hygiene at home and contribute to

caries, gingivitis and periodontal prevention (3 - 5).

On the other hand, orthodontic treatments pose a higher risk of oral diseases (caries, gingivitis and periodontitis) during therapy with both removable and in particular with fixed appliances. The reasons for this are increased biofilm retention, more difficult-to-perform home and professional oral hygiene, and therapy-related changes in the periodontal situation (tooth movement, bone resorption and bone formation).

■ **Keywords:** orthodontology, caries risk, gingivitis, prevention, biofilm ■

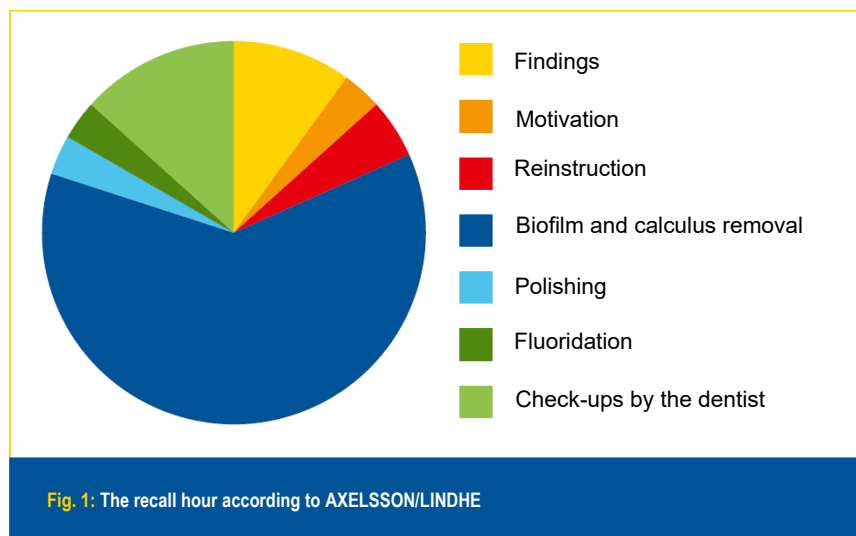


Fig. 1: The recall hour according to AXELSSON/LINDHE

Today, the “ecological plaque hypothesis according to MARSH” (6) is accepted as the etiology of the most important oral diseases. According to this hypothesis, vital sub- and supragingival dysbiotic biofilm is the main cause of the most important oral diseases (caries, gingivitis and periodontitis). Oral health through perfect biofilm management (individual home and professional oral hygiene measures) are the common preventive goal of patients and practitioners.

During orthodontic treatments, this treatment goal can only be achieved with a stringent, systematic, preventive concept. This concept must be based on the work of AXELSSON and LINDHE (7 - 9). They have integrated both pillars of successful prevention (home and professional oral hygiene measures) into their prevention protocol (recall hour) (Fig.1).

Orthodontology and biofilm

Orthodontic appliances promote the accumulation of biofilm. This was demonstrated in the paper by IRELAND et al (10). The results suggest that orthodontic treatment can lead to lasting changes in the quantity and quality of biofilm. A similar conclusion was reached by LUCCHESI et al. in a systematic review (11): Orthodontic appliances affect the oral microbiome with an increase in the number of *Streptococcus mutans* and

Lactobacillus spp. as well as increasing the proportion of pathogenic Gram-negative bacteria. The conclusion of this work is that there is moderate to high evidence for a link between orthodontic appliances and changes in the oral microbiome.

In summary, it can be stated that the quality and quantity of the biofilm already change one month after the start of treatment. The oral microbiome shifts toward an increased caries, gingivitis and periodontal risk. This shift is significantly greater for fixed orthodontic devices than for removable appliances (12).

Orthodontology and Gingivitis/ Periodontitis

The significant change in the oral microbiome, which is particularly evident in patients with fixed

appliances, indicates that the risk of gingivitis is high during the months of therapy and that a risk of periodontitis cannot be excluded (13) (Fig.2).

The insertion of orthodontic appliances already influences subgingival microbial composition during the early phase of orthodontic treatment and increases the prevalence of periodontal pathogens, especially in the molar region (14). In their systematic review aimed at investigating microbial changes in the subgingival biofilm of orthodontic patients, GUO et al. (15) found that orthodontic treatment has an impact on the amount (quantity) and composition (quality) of subgingival biofilm. The concentrations of subgingival pathogens were transiently elevated following insertion of an orthodontic appliance and appeared to return to pretreatment levels after several months. This suggests that orthodontic treatment may possibly not induce permanent periodontal disease by affecting the subgingival biofilm. KADO et al (16) showed that there was a significant increase in obligate and facultative anaerobes in both biofilm and saliva after the insertion of fixed orthodontic appliances.



Fig. 2: Gingivitis associated with fixed orthodontic treatment

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Fig. 3: WSLs after debonding

They conclude that fixed orthodontic appliances induce measurable changes in the oral microbiome. This leads to dysbiosis, which correlates with a shift in the microbiome from healthy to diseased (periodontitis).

In summary, the literature does not present a consistent picture. Contradictory results have been reported regarding the effects of fixed appliances on subgingival biofilm and its sequelae.

Orthodontology and caries

As early as 2001, JOST-BRINKMANN was able to show that the risk of caries and gingivitis increases during orthodontic treatment. Patients treated with fixed devices exhibited more initial carious lesions than untreated patients (17). The American Dental Association (ADA) (18) considers the insertion of fixed orthodontic devices to be an increased risk of caries. It recommends treating patients with fixed orthodontic devices as high-risk patients during the treatment period.

In their meta-analysis, SUNDARARA et al (19) concluded that an average caries prevalence of 68% and an incidence of 49% can be expected in orthodontic treatment, especially with multibracket appliances. Their conclusion was that the incidence and prevalence rates of white spot lesions

(WSLs) in patients undergoing orthodontic treatment are quite high and significant (Fig. 3). This widespread problem of WSLs development is an alarming challenge and requires great attention from both patients as well as dentists and their prevention teams.

In their review paper on the topic of initial lesions during orthodontic treatment, HÖCHLI et al. (2017) clearly highlighted the problems that exist in the relationship between orthodontic treatment and an increase in initial lesions (20). As early as 1988, ØGAARD et al. demonstrated that first lesions in teeth with fixed orthodontic appliances could already be observed after four weeks (21). BROWN et al. (2016) showed that patients with orthodontic appliances in private practice developed white spot lesions in approximately 28% of cases. WSLs occurred more frequently in patients with poor oral hygiene as well as in patients with a longer duration of treatment. The risk for this group to develop WSLs is 2.1- to 3.5-fold higher (22).

Summary: orthodontic appliances increase biofilm retention and promote the formation of WSLs.

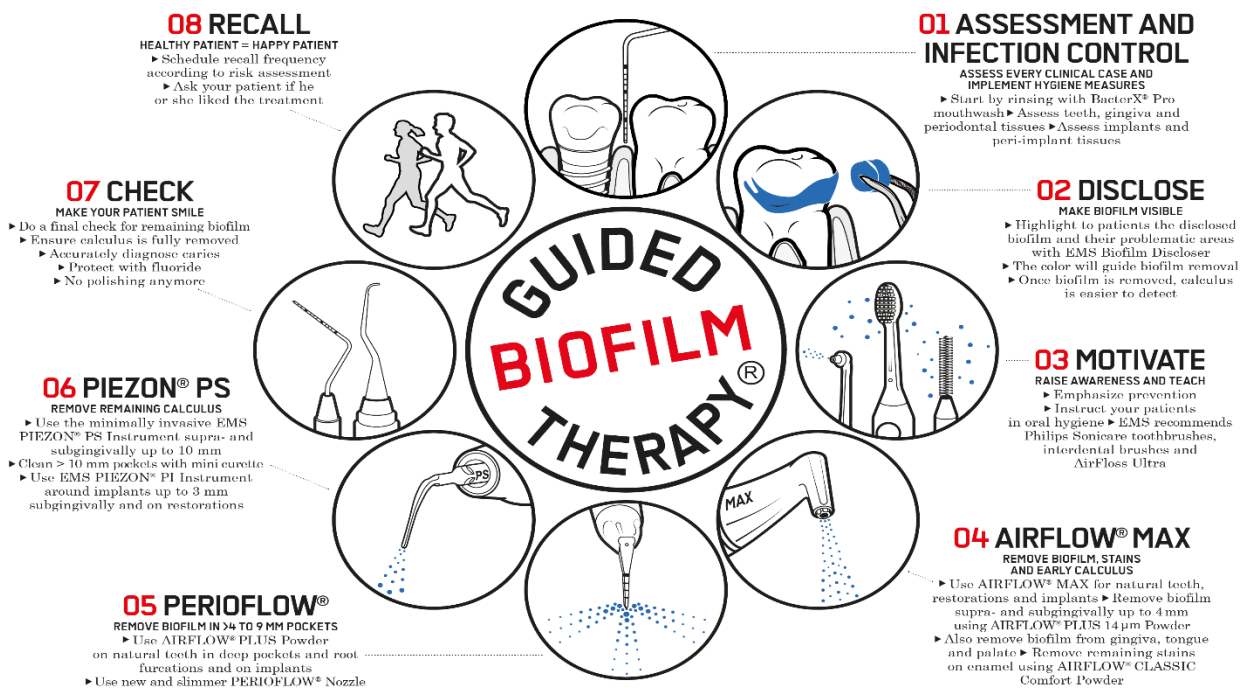


Fig. 4: Guided Biofilm Therapy (© Dr. Klaus-Dieter Bastendorf)

Decalcification of the enamel surface adjacent to fixed orthodontic appliances in the form of white spot lesions is a common and well-known side effect of orthodontic treatment (23, 24). Preventive care during orthodontic treatment must lead to a greater emphasis on effective caries prevention.

Orthodontics and systematic prevention

Fixed orthodontic appliances and removable orthodontic appliances can increase the risk of caries, gingivitis and periodontitis (24). This is clearly evidenced by the above cited literature. Orthodontic treatments may only be performed if they are accompanied by a stringent, systematic, preventive concept. The preventive concept must be guided by the two-pillar model of AXELSSON and LINDHE (8, 9). It must include measures of both home and professional oral hygiene. The concept of AXELSSON and LINDHE is more than 50 years old (see Fig. 1). State-

of-the-art preventive protocols must take into account scientific progress and technological advances. Guided Biofilm Therapy (GBT) is a proven state-of-the-art prevention protocol developed by practitioners, universities and EMS (Fig. 4) (24, 26). GBT is an evidence-based, individual, risk-oriented, systematic, modular, universally applicable (even for complex “cases”) prevention protocol which can be applied in all age groups. As GBT is a modular system consisting of eight steps, the workflow protocol can be adapted perfectly to the needs of patients during orthodontic therapy.

The individual steps of GBT during orthodontic treatments:

1 a. Infection control

Any dental treatment must begin with protecting employees against infection. Prior to each treatment, we have the patients rinse with BacterX®Pro (chlorhexidine digluconate/ CHX 0.1%, cetylpyridinium chloride (CPC) 0.05%, sodium fluoride 0.005%). This rinse has become even

more important due to the corona pandemic. The combination of CHX and CPC demonstrates outstanding activity against bacteria and viruses (especially SARS-CoV-2) and thus contributes significantly to reducing the risk of infection (27).

1 b. Collecting and documenting findings, making diagnoses

The collection of the relevant PT and caries findings, including the age-specific medical history to determine the individual risks (28), is a basic prerequisite for any preventive measure. In the orthodontic treatment of children and adolescents, the main focus is on diagnosing the risk of caries. With the aid of an age-specific medical history, which also includes detailed questions on tooth cleaning, nutrition and fluorides, the general risk of caries is assessed using the recording form of the University of Bern (Fig. 5) (24).

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DR. STRAFELA-BASTENDORF
Familien-Zahnarztpraxis

Risikoanalyse Karies bei Kindern ab dem 7. Lebensjahr
(Zutreffendes wird durch Fachperson angekreuzt)

	karieshemmend	kariesfördernd
Zahngesundheit beeinflussende Medikamente (zuckerhaltige Medikamente, Sirup usw.) bei „ja“ ankreuzen	<input type="checkbox"/>	<input type="checkbox"/>
Kind mit Migrationshintergrund oder niedrigem sozioökonomischen Status bei „ja“ ankreuzen	<input type="checkbox"/>	<input type="checkbox"/>
Kieferorthopädische Apparatur bei „ja“ ankreuzen	<input type="checkbox"/>	<input type="checkbox"/>
Viel Plaque an Glattflächen 2 Kreuze bei „ja“	<input type="checkbox"/>	<input type="checkbox"/>
Zuckerimpulse (Stacks, Bonbons usw.) 1 Kreuz ab 6x pro Tag 2 Kreuze ab 6x pro Tag	<input type="checkbox"/>	<input type="checkbox"/>
Karies (inkl. Kreideflecken), Füllungen in den letzten 2 Jahren 1 Kreuz 1x 2 Kreuze 2x 3 Kreuze ab 3x	<input type="checkbox"/>	<input type="checkbox"/>
Mundhygiene mit Fluoridzahnpaste 1 Kreuz 1x pro Tag 2 Kreuze ab 2x pro Tag	<input type="checkbox"/>	<input type="checkbox"/>
Professionelle Prophylaxe 1 Kreuz 1x pro Jahr 2 Kreuze 2x pro Jahr 3 Kreuze ab 3x pro Jahr	<input type="checkbox"/>	<input type="checkbox"/>
Zusätzliche präventive Massnahmen (Fluorid-Spülung, Fluorid-Salz, Xylitol usw.) bei „ja“ ankreuzen	<input type="checkbox"/>	<input type="checkbox"/>

Maßnahmen zur Reduzierung des Kariesrisikos (immer zu empfehlen, wenn mehr rot als grün)	
1.	
2.	
3.	

Stand: 08.2018

Fig. 5: Caries risk analysis form (recording form of the University of Bern)

The form is based on the “Dentodine” software (29). In our practice, the gingival and periodontal findings, including the necessary indices, are recorded and documented in *Paro Status*® (ParoStatus.de GmbH).

Only patients who do not have an increased risk of caries and/or PT may receive orthodontic treatment.

2. Disclosure of the supragingival biofilm

An indispensable step in professional prevention is disclosure of the supragingival biofilm (Fig. 6). Only when biofilm is made visible by disclosure (Hellwege “Making visible makes insightful”) can an accurate plaque index be established. Only with

disclosure can the patient (and the accompanying person) be specifically instructed and motivated to improve oral hygiene at home. Only when the biofilm has been made visible by disclosure can the clinician remove biofilm in a targeted (guided) professional manner. As only those tooth surfaces are treated where biofilm is also present, this also contributes to substance conservation (7, 9, 30).

The more recent literature can be summarized as follows: perfect supragingival biofilm removal is only possible with disclosure (31, 32).



Fig. 6: Disclosure of biofilm

3. Measures for homecare

The cornerstones of successful prevention (homecare and professional oral hygiene measures) according to AXELSSON and LINDHE still apply today. The importance of adequate oral hygiene to maintain oral health in the context of orthodontic therapies is particularly important due to the aggravating circumstances.

3 a. Homecare

Cleaning of teeth at home during the period of orthodontic therapy is a particular challenge purely because of the increase in artificial retention sites. This is also reflected in the literature. Only excellent and good oral hygiene were independent prognostic factors for the prevention of severe WSLs (33). MIGLIORATI et al. (2015) summarized the results of their systematic review as follows: regular motivational sessions and mechanical tooth cleaning by a dental hygienist help to maintain good oral hygiene during fixed orthodontic treatment (34). In their study, OZLU et al. (2021) concluded that an oral hygiene program in advance of orthodontic treatment leads to significantly better results when oral hygiene instructions and motivation are supported by videos or accompanied by a practical training program (35). The paper by MEI et al. (36) can act as a summary and guide for homecare measures in practice. Less biofilm was observed in patients who were self-motivated and

brushed their teeth more often. Regular use of fluoride mouth rinses and toothpastes may prevent the development of lesions around orthodontic brackets.

The determined caries risk forms the basis of our prevention program. For patients with orthodontic appliances, disclosure, motivation and education on proper oral hygiene are essential. In our practice, we refer to this as “guided cleaning”. Recommendations for homecare are customized according to the patient's knowledge and abilities. Involvement of the legal guardians is necessary. Our approach consists of three steps: we recommend the individual oral hygiene tools (“tell”), we demonstrate their use (“show”) and we practice their application (“do”).

The usual aids for mechanical tooth cleaning at home or specific aids (developed for orthodontic situations) are available (37). In our practice, we operate a dual system, which means that everything we communicate to our patients is additionally given to them in writing.

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Fig. 7: Airflow Max application for fixed orthodontic treatment

3 b. Chemically supportive home therapy

It is considered to be proven that local fluoride application, in particular through fluoride toothpastes and fluoride varnishes, is responsible for the decrease in caries prevalence and experiencing caries (38). Toothpastes have a very important function in the prevention of caries, gingivitis and periodontitis. The main focus is on the prophylactic effect against caries due to the contained fluoride (39). This holds particularly true during orthodontic treatment and the resulting difficult cleaning conditions.

The objective of the work by BERGSTRAND et al. (2011) was to update the evidence for primary and secondary prevention (treatment) of white spot lesions (WSLs) close to fixed orthodontic appliances. The results consolidated the use of topical fluorides in addition to fluoride toothpaste as the best evidence-based method for preventing WSLs (40).

LUSSI et al. (2020) showed that carious lesions are not uncommon during orthodontic treatments, particularly in the anterior and canine regions. The tooth surfaces are in constant contact with their environment: with saliva, biofilm and everything entering the mouth. In order for teeth to remain intact, not more material may be released than is re-integrated. A dynamic equilibrium

prevails. This can be decisively influenced by appropriate nutrition and oral hygiene. Fluoride has a positive effect on this balance due to its properties (24).

In multiband treatment, highly dosed fluorides (12,500 ppm fluoride) and mouth rinses as part of homecare can help to prevent damage to the tooth structure (41).

3 c. Nutritional guidance

Nutrition plays an important role in the multifactorial development and progression of caries. It is not the absolute amount of sugar, but the timing and frequency of sugar absorption and its retention time ("stickiness") that are critical (42). Fixed orthodontic appliances represent additional retention elements for fermentable carbohydrates. A successful prevention program during orthodontic treatment therefore specifically includes nutritional guidance.

4. and 5. Professional removal of biofilm

The aids for the actual professional mechanical plaque removal (PMPR) - (AXELSSON/ LINDHE spoke of "active interventions") - included hand instruments (scalars and curettes) and rotary instruments (rubber polishers and brushes) in conjunction with prophylactic pastes. These aids must be adapted to scientific findings (biofilm

management is the focus) and technical progress (cleaning performance, substance protection, patient and practitioner comfort). Not only does oral homecare pose a special challenge, but so does professional biofilm removal during fixed orthodontic treatment. The aids used in fixed orthodontic treatment represent retention sites for biofilm. The commonly used aids (toothbrush with toothpaste at home, cleaning with rotary aids in the practice) do not reach important areas. New methods such as Guided Biofilm Therapy (GBT) and the aids used in GBT (Airflow, Piezon) provide for better cleaning of the bracket environment (24) (Fig. 7).

New comparative literature on targeted biofilm removal clearly shows that perfect, substance-sparing biofilm removal with optimal patient and practitioner comfort is not possible with classic cleaning (Rubber Cup Polishing/RCP), hand instruments and modern airflow. The Airflow handpiece with Plus powder (supragingival and subgingival up to 4 mm) is predominantly used for orthodontic prevention in children. A special Perioflow handpiece is available for periodontal diseases with deep defects, which is also used with Plus powder (subgingival from 4 to 9 mm).

In an in vitro study, AREFNIA et al. (2021) were able to demonstrate that the best deep cleaning of enamel is achieved with erythritol powder airflow (EPAF) alone. Additional "polishing" did not result in better results (43). These results confirm the findings of CAMBONI and DONNET (2016): EPAF does not cause any changes on enamel and cleans it far more gently and thoroughly than RCP (44)

In an in vivo study, WOLGIN et al (2021) compared RCP versus EPAF in supragingival biofilm removal.

They showed that EPAF achieved significantly better supragingival biofilm removal results than RCP on both the anterior and posterior teeth. After 24 hours, new formation of biofilm was lower after EPAF than with RCP (45). AL KHATIB et al (2021) compared EPAF versus RCP and other cleaning methods in children with fixed orthodontic appliances. The initial results after 24 weeks were that EPAF cleaning is more effective and time efficient compared to other methods. This is particularly evident in cleaning below the arches, in the interdental space and in the bracket environment (46).

6. Calculus removal

Calculus is the mineralized form of biofilm. Calculus is not a primary cause of oral disease but only exerts a

secondary effect on the pathogenesis of oral diseases. It facilitates the retention of biofilm and complicates oral homecare.

In the GBT protocol, biofilm is removed first as the main cause of the most important oral diseases. This is followed by targeted supragingival and subgingival scaling with piezo-electric ultrasound (*PIEZON[®]NO PAIN PS*). Targeted means that ultrasound is only applied where calculus is really present (where we see calculus!). Subgingivally means that we orient ourselves on our PT findings and on our probe findings (Hu-Friedy explorer 11/12) (where we can feel calculus!). The effectiveness of the approach (first remove biofilm and discoloration, then mineralized deposits) is confirmed in two papers (47, 48). Both showed that this sequence achieved better cleaning

while saving time and increasing patient comfort at the simultaneously. Ultrasonic instrumentation around the bracket base reduces the shear bond strength of metal orthodontic brackets (49). This highlights the need to only use ultrasonic systems that work gently. The *PIEZON[®]NO PAIN PS* system is particularly suitable for this purpose. With this system, the focus is on high efficiency and substance preservation (50 - 52).

7. Quality Control

All successful preventive concepts are only possible in a team with motivated professional staff where everyone works within the scope of their roles.

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According to the German Dentistry Act (ZHG), the practice of dentistry requires a license as dentist. The dentist is obliged to provide services personally and is personally responsible to the patient for the entire treatment. Supervision by the dentist is indispensable for proper delegation. The following cannot be delegated: indication, examination, diagnosis, therapy planning, invasive procedures (53).

Quality control is performed over several steps. In our practice, all staff involved in prevention work with magnifying glasses. First, the employee checks their own performance in the context of strict self-control. This may require control disclosure. This is followed by the final examination and diagnoses by the dentist (supervisory duty). In patients undergoing orthodontic treatment, the final examination of the dental hard substances according to the “International Caries Detection and Assessment System” (ICDAS) together with the corresponding documentation are essential (54). This examination presupposes perfect professional cleaning of the teeth.

The final step is made up of chemical support measures (professional fluoridation), which prove particularly successful if preceded by perfect biofilm management. It is considered to be proven that local fluoride application, in particular through fluoride varnishes, is responsible for the decrease in caries prevalence (37). This was confirmed in the paper by BERGSTRAND et al. (40). The most pronounced effect on caries reduction was obtained with the regular professional application of fluoride varnish around the bracket base. The work of PERRINI et al. (55) also reached a similar conclusion: The regular application of fluoride varnish can provide a certain amount of protection against WSLs, but not to a statistically significant extent.

8. Recall

Recall appointments for patients during orthodontic treatment should be scheduled at shorter intervals to ensure

close monitoring and to detect early periodontal inflammation or caries at an early stage and improve patient compliance (56). The recall intervals are agreed on the basis of the individual PT and caries risk determination. To make prevention successful, it is necessary for the recall to be coordinated between the family dentist and the orthodontist. In our practice, and in consultation with our orthodontists, we also take on responsibility for oral health during the period of orthodontic treatment. Throughout the treatment period with fixed orthodontic appliances, the patients are enrolled in a risk program with us (18), in other words, these patients attend the practice every three months for GBT treatment. Of course, family dentists and orthodontists can make other arrangements. However, the responsibility for oral health must be in the same hands. Performing straightforward “bracket cleaning” when replacing wires at the orthodontist's has also proven to be effective. Airflow technology and low-abrasive powders make “bracket environment cleaning” easy, fast, effective and painless (57).

Orthodontics and sealing

Within the context of fixed orthodontic therapies, the use of dental sealants has been extended to smooth enamel surfaces. In the last decade, orthodontic surface sealing has become one of the most popular methods to prevent demineralization during orthodontic treatment with fixed appliances. However, the scientific literature contrasts with the frequent use of “smooth surface sealants”. Recent literature, in particular, has been critical of the protective effect of surface sealing. HAMMAD and KNÖSEL (2016) found that no significant effect on the incidence of caries was observed with sealing (33). KNÖSEL et al. (2015) commented that it is unlikely that a single application of OpalSeal will last throughout the fixed appliance treatment phase.

On average, it can be assumed that a repeat application of sealant is necessary after 3.5 months (week 14) (58).

The conclusion of the work of SEN et al. (2021) can be summarized as follows: In patients with fixed orthodontic appliances who received a surface sealant, the integrity of the protective layer was lost in more than 50% of cases after three months. The coating thickness of the sealants was reduced significantly after 3-6 months (57). Summary/clinical relevance: The protective effect against demineralization lesions of orthodontic sealants in patients treated with fixed appliances appears to be limited in time. Further preventive measures (“bracket environment Airflowing”) should be investigated and applied.

Summary

Since the groundbreaking work of AXELSSON and LINDHE (7-9), it has been known that lifelong oral health is possible with prevention programs. If one implements the tools of AXELSSON and LINDHE's work into everyday practice, results similar to those achieved by AXELSSON and LINDHE are possible (59, 60).

Orthodontic treatments are common and effective means for treating misaligned teeth (malocclusion). Orthodontic treatments with both removable and in particular with fixed appliances pose a higher risk of oral diseases (caries, gingivitis and periodontitis) due to the more difficult conditions (artificial retention sites, more difficult homecare and professional tooth cleaning) (61). Optimal balance between homecare and professional oral hygiene measures is necessary to maintain oral health. There are various prevention protocols, all of which follow the guidelines of AXELSSON and LINDHE. There is no standard prevention protocol for the duration of orthodontic treatment. GBT is suitable as a standard prevention protocol because of the evidence in the scientific literature regarding each partial step and the flexibility of its modular structure. *Pi*

Conflict of interests

In the interests of transparency, Dr. Klaus-Dieter Bastendorf would like to declare that he is a member of the “Scientific Board” of E.M.S. Electro Medical Systems S.A., 1260 Nyon – Switzerland. There is no conflict of interests for Dr. Nadine Strafela-Bastendorf.

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