Prevention of white spot lesion formation during treatment with fixed orthodontic appliances

The efficacy of using a fluoride rinse and repeated oral hygiene instructions

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CHAPTER 7

SUMMARY
Orthodontic treatment aims towards a stable occlusion and masticatory function, but also on achieving an aesthetical end result in forms of smile and profile. Fixed orthodontic appliances may lead to formation of dental caries. During treatment there is an increased number of plaque retention sites and oral environment changes, resulting in different plaque composition. Because of these alterations, decalcifications can form around the orthodontic brackets, at locations normally showing a low prevalence of caries. These so-called white spot lesions (WSL) are obviously an (aesthetically) unwanted side effect of orthodontic treatment. To prevent the formation of WSL during fixed orthodontic appliance treatment several methods have been studied. Patients can use a daily rinse with, for example, fluoride, or can use high-fluoride toothpaste. Moreover, practitioners can apply varnishes containing fluoride during every check-up visit.

In this thesis two randomized clinical trials (RCTs) are described with the overall topic the prevention of WSL formation during fixed appliance treatment. The first chapters describe a RCT about the effects of the use of a fluoride rinse on the formation of white spot lesions and the microbiome during treatment. The second RCT aims at the oral hygiene instructions given during treatment to maintain good oral health.

In chapter 2 the use of a fluoride rinse (Elmex caries protection with a combination of 150 ppm sodium-fluoride and 100 ppm amine-fluoride) was compared with a placebo rinse. This study was performed as a randomized clinical trial (RCT). The rinse was used every evening after tooth brushing starting at placement of fixed appliances and lasting till the end of treatment. A total of 81 participants (mean age 13.3 years) completed the study. Before treatment and around six weeks after debonding WSL and Decayed, Missing and Filled Surfaces (DMFS) were assessed. Bleeding scores were measured before start, during and post treatment. The mean treatment period with fixed appliances was 24.5 months. For the measurements of the demineralizations the method of Quantitative Light-Induced Fluorescence (QLF) was used. In the fluoride group 31% of the participants developed at least one demineralization, compared to 47% in the placebo group. A maximum of five lesions per participant was seen in the fluoride group, compared to a maximum of 15 lesions in the placebo group. Gingival bleeding increased significantly in the placebo group from one year after start of treatment compared to the bleeding scores before placement of the fixed appliances. In the fluoride group the bleeding scores during treatment were not different from those before start of treatment. We conclude that using a fluoride rinse, containing sodium- and amine-fluoride, daily at home, during treatment with fixed appliances has a positive preventive effect. Fewer WSL are formed and gingival health, measured as bleeding, remains stable.
Because of the increased number of plaque retention sites, in combination with a more difficult oral hygiene, more plaque is formed. The effect of fixed appliances on the oral microbiome is investigated in chapter 3, with data from the RCT described in chapter 2. The changes in the oral microbiome were investigated before, during and after orthodontic treatment combined with the use of either a fluoride rinse or a placebo. At six time-points during the study plaque samples were taken; once before placement of the appliances, twice in the first phase of treatment, just prior to debonding and twice after removal of the appliances. From 91 participants (mean age 13.3 years) one or more supragingival plaque samples were obtained. The microbial changes were assessed using next-generation sequencing of the bacterial 16S rRNA gene. The fluoride rinse had little effect on the oral microbiome composition during treatment with fixed appliances compared to the placebo. The microbial changes observed in relation to gingival health, measured as bleeding, and orthodontic treatment and time were more pronounced. In the first three months of orthodontic treatment periodontal pathogens (e.g. Selenomonas and Porphyromonas) were highest in abundance. Most genera, such as Streptococcus, Rothia and Haemophilus, which increased in time are associated with a healthy oral cavity. This increase in healthy associated genera was the only, though minor, change that remained after end of treatment. We conclude that the orthodontic treatment during puberty does not have a lasting negative effect on the oral microbiome. A drawback of our study is the fact that we lack an age-related control group not receiving orthodontic treatment. This means that we cannot discriminate between changes in microbiome over time caused by age or by the fixed appliances.

In the above-mentioned RCT the use of QLF to assess WSL longitudinally during treatment with fixed appliances appeared to be difficult. The presence of a bracket, wire and other auxiliaries in combination with the movement of the teeth (i.e. rotations) obscured parts of the lesion. This is further investigated in an in vitro study described in chapter 4. The reproducibility of WSL assessments was investigated when using a QLF-Digital (QLF-D) camera to detect and monitor the area and fluorescence loss of WSL. Reproducibility was assessed for different angles of rotation of teeth with or without brackets, and with or without an attached hook to the bracket or containing an elastic ligature and wire. The brackets were bonded on maxillary incisors or maxillary canines. Demineralizations were formed in vitro directly cervical of the bracket. Images of the lesions were captured using a QLF-D camera mounted on an optical bench, equipped with a goniometer on a turntable. The teeth were placed in the goniometer simulating buccolingual rotations and the turntable was used for mesiodistal rotations. The images were captured at combinations of different angles of rotation before (with and without a wire) and after debonding, the brackets of the canines contained a hook on the bracket. The image after debonding without rotation served as a control. The presence of a bracket (with or without an elastic ligature and wire) resulted in
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A significantly higher fluorescence loss, yet a smaller lesion area ($p < 0.05$) in comparison to the control. A significant higher fluorescence loss was seen for rotations towards lingual, this was less explicit for the rotations towards buccal. We conclude that fluorescence loss and lesion size are influenced by the angle of rotation under which the WSL is photographed during orthodontic treatment. In research settings, during treatment with fixed appliances, QLF-D should therefore to be used with precaution, since too many alterations take place over time, and because of the presence of auxiliaries.

Next to the use of additional fluoride, maintaining good oral health during orthodontic treatment is important to prevent the formation of WSL. In chapter 5 the effect of repeated oral hygiene instruction with three different feedback methods on the level of plaque is tested in a RCT during orthodontic treatment. This study started around six months after placement of the fixed appliances. During four study visits participants received feedback (on all four visits) and oral hygiene instructions (only during the first three visits). The four study visits took place just prior to the regular check-up visits, planned around every six weeks. After feedback or instructions the participants brushed their teeth. They could either use a manual or electric toothbrush, and interdental brushes. The feedback methods involved 1) showing a QLF image of their own teeth, 2) using a disclosing agent to stain their own teeth, 3) using a mirror and probe to indicate the presence of plaque. Before and after feedback and brushing QLF-images of the anterior teeth were made. A total of 87 participants completed the study. Between the three groups no differences in the level of plaque before and after feedback and brushing were seen as assessed on the QLF images. A non-clinically relevant, yet statistically significant decrease in plaque was found between the four study visits. When dichotomizing the total patient group the group starting with a moderate to high level of plaque present showed a statistically significant and clinical relevant decrease in plaque. A direct improvement was also seen in the efficacy of brushing immediately after feedback using a QLF image or a mirror and a probe. We conclude that repeated instructions during orthodontic treatment can help to lower the level of plaque in patients with a moderate to high level of plaque. This finding was made regardless of the feedback method used.

Based on the above-mentioned RCT’s we have two clinical advises, that can be easily incorporated in daily practice in the Netherlands. In the first place the daily use of a fluoride rinse should be promoted during treatment with fixed appliances. Secondly, if oral hygiene is inadequate during treatment, repeated instructions should be given in order to decrease the level of plaque.