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 6

GENERAL DISCUSSION AND CONCLUSIONS
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A large proportion of the youth receives orthodontic treatment. In the Netherlands, between 60% and 80% of the group of 17 and 23 year olds has received orthodontic treatment (Schuller et al., 2018). During treatment with fixed appliances an impaired dental hygiene and altered microbiome are seen. This, in combination with a diet with a high-frequency intake of carbohydrates, typical for the high-school population, can lead to dental caries.

In the Netherlands the caries prevalence of five year olds has declined in the last decades, while the caries prevalence of eleven year olds has increased (Schuller et al., 2018). For the 17 and 23 year olds the caries prevalence was stable. In the previous epidemiological study of 2011 the caries prevalence had declined in both groups (Schuller et al., 2013); the current data show that this decline has come to a halt. These numbers indicate that during orthodontic treatment there is a need for measures to maintain good oral health which can reduce the development of white spot lesions (WSL).

Altered microbiome and gingivitis during treatment

In this thesis it is shown that placement of fixed appliances is associated with a change in the oral microbiome: More periopathogens, such as the genus Prevotella and Selenomonas, were observed in the first three months after placement. The differences that were found in bacterial composition between the subjects who received the fluoride rinse and those in the placebo rinse group had little effect. This is similar to the conclusion that the main effect of fluoride is on the demineralization and remineralization processes in the oral cavity (van Loveren, 2001, ten Cate, 2009, Rosin-Grget et al., 2013, ten Cate, 2013).

Gingivitis during orthodontic treatment is attributed to plaque accumulation caused by the increased number of retention sites and consequently impaired oral hygiene (Naranjo et al., 2006, Ren et al., 2014). Not only the orthodontic treatment is related to the onset of gingivitis in these patients, puberty is often also associated with increased gingivitis (Morishita et al., 1988, Mombelli et al., 1990, Nakagawa et al., 1994). Generally, orthodontic treatment takes place during puberty. During this period, the human body experiences hormonal changes (Vetter-O’Hagen and Spear, 2012). In this thesis, it is shown that in subjects with gingivitis more Porphyromonas were detected in the first three months of fixed appliance treatment in comparison to persons with a healthy gingiva. This difference disappeared towards the end of treatment and after debonding, although the percentage of subjects with gingivitis increased. A possible explanation for the decrease of Porphyromonas towards the end of treatment might be due a reduction in retention sites because of alignment of the teeth. Also removal of the appliances or hormonal changes could explain the difference. This thesis shows that the bacteria that were associated with periodontal pathogenesis decreased at the end of treatment and after removal of the fixed appliances, while the prevalence of health related bacteria increased, suggesting that
orthodontic treatment during puberty does not have a lasting negative effect on the oral microbiome. We note that our study did not include a control group of adolescents that did not receive orthodontic treatment. Therefore it is difficult to discern which microbial changes are related to orthodontic treatment, and which to the onset of puberty.

**Preventive measures during treatment: additional fluoride**

Efforts to prevent the development of WSL should be implemented by orthodontists, dentists, the patients and their parents/caretakers. One of these measures is the administration of extra fluoride during treatment with fixed appliances. It has been reported that the use of a high-fluoride toothpaste instead of regular fluoride toothpaste resulted in fewer WSL (Sonesson *et al.*, 2014). The latter is a home-care procedure and therefore relies on compliance, an action to be taken by the patient and their parents/caretakers. It is cost-effective compared to professionally applied fluoride varnish, which has also been shown to reduce the incidence of WSL (Stecksen-Blicks *et al.*, 2007). An advantage of the latter is that it relies less on the compliance of the patient as it is applied periodically by a professional; either the orthodontist, dentist or oral hygienist. In the Netherlands, questionnaires taken in 2004 and 2008 showed that orthodontists seldom prescribed a fluoride gel or varnish, in spite of evidence that it is effective (Derks *et al.*, 2007, Kerbusch *et al.*, 2010). This might be due to regulations in the Netherlands, where orthodontists cannot invoice these methods of prevention. These questionnaires also showed that a fluoride rinse was prescribed frequently. Fluoride rinses are home-care products, which are easily available in contrast to the earlier mentioned high-fluoride toothpaste, which in the Netherlands can only be obtained with prescription. Next to only being available on prescription it is registered only for the group above 16 years of age and not fully covered by the insurance companies. Our study concluded that using a fluoride rinse daily, in the evening after brushing, reduces the incidence of WSL. A disadvantage of using a rinse is the above mentioned issue of compliance. It is reported that there is a significant association between compliance and WSL formation (Geiger *et al.*, 1988). A poor compliance was reported in over 50% of the subjects in that study. The investigators gave verbal instructions or instructions on paper and occasionally during treatment. Especially when oral hygiene was poor, they urged patients to improve their oral hygiene and use the rinse. Compliance was not assessed in our study and it is expected to be similar in the fluoride group and in the placebo group. Nevertheless, a positive effect of the fluoride rinse on WSL formation was found. The compliance in our study is expected to be slightly better than in the previously mentioned study (Geiger *et al.*, 1988). The instructions given in our study were given in the same frequency as in the study of Geiger. Compliance is presumed to be better in our study since the patients were seen on research visits every six months and the rinse was supplied and handed out by the researchers. Besides the lower WSL formation the bleeding scores were unaltered during treatment in the group using fluoride rinse, while in the placebo group bleeding was increased from
one year into treatment. Therefore, it is concluded that using an additional fluoride rinse results in fewer WSL and helps to maintain better oral health. Prescribing a fluoride rinse is a good option to prevent WSL during orthodontic treatments in the Netherlands, since it is easily available and cost-effective for the Dutch orthodontist.

**Preventive measures during treatment: oral hygiene instructions**

A healthy mouth and good oral hygiene help to prevent the formation of WSL (Artun and Brobakken, 1986, Chapman et al., 2010, Khalaf, 2014). It is customary to give oral hygiene and dietary instructions to the patient at the start of treatment with fixed appliances. Repeated oral hygiene instructions, beginning from the start of treatment showed a decreased plaque index (Marini et al., 2014, Peng et al., 2014). The instructions were repeated every four weeks in the study by Marini et al (Marini et al., 2014), in which also the plaque level without instructions decreased over time. A possible explanation for this was not given, but a Hawthorne effect could be responsible, since plaque was measured every 4 weeks in both groups. In the study of Peng et al. (Peng et al., 2014), which also started at placement of fixed appliances, the oral hygiene improved by showing images with severe consequences of biofilm accumulation. An elevation in plaque was seen for the group receiving instructions together with the use of a discoloring agent, which remained at the same level independent of the repeated instructions. The current study showed repeated instructions, starting at 6 months into treatment, did not have a clinically relevant effect on the level of plaque. This was found irrespective the method of feedback used. For the group starting with a high level of plaque, a decrease was found over time after repeated oral hygiene instructions. Therefore, it seems important to assess risk factors before treatment start and give attention at the beginning of treatment, as well as further on, to the patients with inadequate oral hygiene. It is well documented that inadequate oral hygiene at start and during treatment are risk factors for the development of WSL (Al Maaitah et al., 2011).

**The use of QLF for the purpose of research and in daily practice**

In research settings, longitudinal assessment of WSL is often required. QLF can be used for longitudinal observation in a non-bracketed population (Tranaeus et al., 2002). Images of teeth with a lesion could be taken in a reproducible way by different persons, just as the subsequent analyses of the images were found to be reproducible. A longitudinal assessment of demineralizations during fixed appliance treatment is hampered by practical limitations: during orthodontic treatment, brackets and other accessories are present, which can all obscure part of the lesion. This interference is enhanced by the fact that healthy surrounding enamel should be present for QLF measurements. This is not the case when brackets are present. Moreover, positions of teeth will change during the treatment period, which hampers the comparison of pictures taken at various time points. Orthodontic studies showed that QLF images captured under similar circumstances, that is using the
same camera angle, can be reproducibly quantified in vitro (Benson et al., 2003, Pretty et al., 2003, Aljehani et al., 2004). This thesis presents in vitro research, in which changes that may occur during orthodontic treatment are mimicked. For that purpose, the images were made under various conditions, that is, with brackets with or without wire, without brackets and under different angles of rotation, mimicking the change in tooth position. The results showed that fluorescence loss and lesion size are influenced by the angle of rotation under which the WSL is photographed. The full extent of demineralizations is only apparent after removal of the fixed appliances, when photographed at rotations of 0° mesiodistal and up to 20° buccal.

QLF is also used and promoted to visualize the presence of plaque. Porphyrins in matured bacterial plaque form a red fluorescence, which can be shown on a QLF image. The patient is able to remove plaque after seeing such a QLF image with instructions how to interpret the image. In an adolescent orthodontic population, the repeated use of in office feedback with QLF did not decrease the amount of plaque over time (Miller et al., 2016). For research purposes assessing plaque on QLF images in combination with a discoloring agent was found to be difficult. Discriminating between the remnants of the discoloring agent and red fluorescence was found to be problematic. After staining, the plaque level assessed on QLF images was higher than without staining (Pretty et al., 2005). Our study concluded that, when a high level of plaque was present, the plaque decreased in time after repeated oral hygiene instructions, independently of the method of feedback used. From the above, we conclude that when no precautions are taken with respect to standardization, QLF can be used in normal practice settings for the purpose of instructing the patient regarding oral hygiene and to make the WSL visible. However, for research purposes during orthodontic treatment QLF was found insufficiently reliable for monitoring WSL over time.

**Clinical advices**

During treatment with fixed appliances the orthodontist, dentist, oral hygienist, patient and parents/caretakers have joint responsibility. First of all the orthodontist should prescribe the use of a fluoride rinse during treatment with fixed appliances. This should become a routine in all orthodontic practices, and this procedure should be emphasized by the whole staff, and other dental professionals, throughout the treatment in order to motivate the patient to be compliant. Regarding maintaining good oral health during orthodontic treatment this thesis showed that starting extra oral hygiene instructions already into treatment did not have an effect on the level of plaque for the patients who already have satisfactory oral hygiene. However, when oral hygiene was inadequate repeated instructions were found to decrease the level of plaque over time.

Both these advices can be easily incorporated in daily practice throughout the Netherlands and can help to lower the WSL formation in orthodontic patients.
REFERENCES


