Dental Journal
Majalah Kedokteran Gigi

Dental Journal
(Majalah Kedokteran Gigi)
2020 September; 53(3): 170–174

Research Report

# The effect of fixed orthodontic treatment with Edgewise and Straightwire techniques on white spot lesions incidence and accumulation of *Streptococcus mutans* bacteria

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## *ABSTRACT*

***Background:*** *Fixed orthodontic appliances, such as Edgewise and Straightwire techniques, can increase the amount of plaque retention containing Streptococcus mutans (S. mutans), which can lead to white spot lesions.* ***Purpose:*** *The aim of this study is to analyse the correlation of fixed orthodontic treatment with Edgewise and Straightwire techniques on the incidence of white spot lesions and accumulation of S. mutans.* ***Methods:*** *The samples consisted of three groups: control group (n=8), Edgewise technique group, and Straightwire technique group. We observed the samples at the sixth month and eighth month of the treatment, after the installation of the fixed orthodontic appliances. The observation of white spot lesions with caries detector was applied in all regions. Bacterial swabs were acquired in the lateral incisor region, then a bacterial culture procedure was carried out on selective media of S. mutans, and then a bacterial count was performed. The data was analysed using two-way ANOVA, the post-hoc least square differences test, and the Pearson's correlation test.* ***Results:*** *The number of white spot lesions in the Edgewise group was higher than in the Straightwire group in the sixth and eighth month of treatment with insignificant difference (p>0.05). The number of S. mutans bacteria increased in all groups, but there were no significant differences (p>0.05). There was no significant relationship between the number of white spot lesions with the accumulation of S. mutans between groups (p>0.05).* ***Conclusion:*** *The Edgewise and Straightwire techniques increase the incidence of white spot lesions but accumulation of S. mutans with the incidence of white spot lesions has no relationship.*

***Keywords:*** *Fixed orthodontic treatment; Edgewise technique; Straightwire technique; white spot lesions; S. mutans bacteria*

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## INTRODUCTION

There are various bracket designs that have been developed.[1] The fixed appliance technique, which has been widely used, was initiated with the discovery of a bracket with a square slot with a size that is adjusted to each individual tooth, namely the Edgewise.[2] Technique appliance and the development of orthodontic appliance from the Edgewise technique brackets – known as the Straightwire technique – have surface contours to make it easier to insert on long axis points so that they can be placed precisely on the contours of the tooth surface.[3]

There are several stages at the beginning of treatment in the Edgewise bracket technique: levelling and aligning, a correction of individual teeth malposition (such as correction of rotation), crowding and uprighting by requiring archwire or wire bending. Archwire bending causes part of the tooth surface to be closed, making it difficult to clean the oral cavity and teeth, which poses a risk of causing plaque retention when compared to the Straightwire bracket technique – with minimal use of archwire bending.[2,4]

Orthodontic treatment with fixed appliances makes it difficult to clean plaque around the bracket using conventional oral hygiene methods. The ability to self-cleanse plaque with saliva is also reduced. Orthodontic treatment with fixed appliances increases the risk of plaque retention and can increase the risk of caries and

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v53.i3.p170–174

periodontitis.[5] Early development of caries is characterized by white spot lesions (WSLs) on the labial surfaces of teeth, which are quite serious side effects in orthodontic treatment with fixed appliances.[6]

After completion of active orthodontic treatment, the demineralization process will generally be reduced. Some WSLs can remineralize and return to normal, especially visually. However, WSLs can be persistent, which makes the appearance less aesthetic.[7] The emergence of an increase in white lesions in patients, on average, occurs from one month to thirty-six months during treatment, mostly appearing on the surface close to the gingival in premolar teeth because the placement of the bracket in some cases also causes gingival enlargement.[8,9] A study conducted by van der Veen et al.[10] explained that the severity of WSLs observed using light induced fluorescence after fixed orthodontic treatment with the Straightwire technique was more than 60% – it appeared that there were still WSLs.

Patients with fixed orthodontic treatment experience ecological changes in the oral environment, which cause an increase in the number of *Streptococcus mutans* (*S. mutans*) bacteria in saliva and dental plaque.[11] The increase in bacteria in the oral cavity is a major factor in increasing the accumulation of plaque on teeth, and the inflammatory response appears in new areas around the retention area of orthodontic fixed appliance components, such as bands, wires, ligature, or brackets.[12] Research conducted by Kanaya et al.[13] explains that the accumulation of *S. mutans* bacteria can increase up to three months after orthodontic bracket insertion. This study aims to analyse the difference and correlation of fixed orthodontic treatment using Edgewise and Straightwire techniques on the incidence of WSLs and the accumulation of *S. mutans* bacteria.

## MATERIALS AND METHODS

An ethics permit was obtained from the Research Ethics Commission of the Faculty of Dentistry, Universitas Gadjah Mada, Ref: 00299/KKEP/FKG-UGM/EC/2019. The study type is a clinical laboratory experiment.

The sampling of study subjects was conducted by documenting the number of patients in the Orthodontics Resident Clinic of the Orthodontics Department, Prof. Soedomo Dental and Oral Hospital, and Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta in 2019. The selection of subjects was based on research criteria via selected sampling methods in patients with fixed orthodontic appliances, such as Edgewise techniques and Straightwire techniques, and also patients who had not used fixed orthodontic appliances that were or would be treated by orthodontic residents during the 2018–2019 periods. Prior to the study, patients were asked for informed consent as study participants. We classified the malocclusion cases subjects into Angle Class I malocclusion, accompanied by severe crowding, being treated at an early stage of at least six months (T1), and the second stage of eight months (T2), with 16–25 year olds.

After meals but before brushing, subjects that were selected before observation of WSLs were swabbed for bacterial sampling in the maxillary lateral incisors with sterile cotton swabs, which were then put into the 0.98% NaCl solution for further processing in the integrated Microbiology Laboratory of the Faculty of Dentistry, Universitas Gadjah Mada.[14]

Subjects were observed to determine whether there were any WSLs based on the modified WSL index of Gorelick, on the first molars, premolars, canines, lateral incisors, and central incisors of the upper and lower, right and left regions. The examination was followed by these stages: archwire removal, tooth brushing to remove debris, drying the tooth element with a syringe, applying Seek® on all buccal and labial surfaces of the teeth, waiting ten seconds, rinsing all surfaces with a water syringe and brushing or cleaning up the remaining Seek® application material. The surface of the teeth that still appear to have staining from the Seek® application material was the scoring observation area (enamel demineralization) with modified observation and Gorelick scoring records. The Gorelick[15] modification index (Figure 1) was recorded from the first molars, premolars, canines, lateral incisors and central incisors in the upper and lower jaws of the right and left regions.[16]

The results of the bacterial swab were examined and counted at the Microbiology Laboratory of the Faculty of Dentistry, Universitas Gadjah Mada. The first stage of the individual sample immersed in 0.98% NaCl solution was mixed. If there were debris, then centrifugation was carried out and followed with a five-stage dilution of the standard optimization series by inserting 0.2 ml of the solution into test tube 1 containing 0.8 ml of distilled sterile water. After dilution optimization, swab or streaking was performed on the selective media (mitis and bacitracin agar). The sample was stored at 37°C over a 24-hour period. We observed the colony in the media – if it did not appear, we proceeded to check again 24 hours later. In the subsequent observations, when a colony had formed, we counted it with CFU/ml (Colony Forming Unit) = 1 bacterial cell = 1 colony using a colony counter. The number of *S. mutans* bacteria was obtained from the number of colonies, multiplying the dilution factor divided by the calculated solution volume.[17]

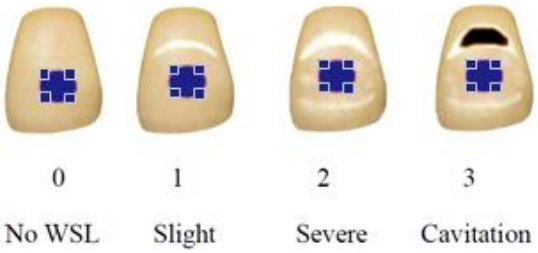


**Figure 1.** Detection of WSLs based on the Gorelick index.[15]

Dental Journal (Majalah Kedokteran Gigi) p-ISSN: 1978-3728; e-ISSN: 2442-9740. Accredited No. 32a/E/KPT/2017.
 Available at http://e-journal.unair.ac.id/index.php/MKG
DOI: 10.20473/j.djmkg.v53.i3.p170–174

We performed statistical analysis using two-way ANOVA tests, followed by the post-hoc least square differences (LSD) test, and continued with the Pearson's correlation test to analyse the relationship of the number of bacteria with the incidence of WSLs. All analyses were made using dedicated statistical software SPSS 16.0 (IBM, Chicago, Illinois, US) at a significance level of 5% ($p$ <0.05).

## RESULTS

The results of observations of the number of WSLs and accumulation of the sixth and eighth month of *S. mutans* bacteria in the control, Edgewise and Straightwire groups can be seen in Table 1. The lowest mean number of WSLs are in the control group, followed by the Straightwire group and the highest in the Edgewise group. The mean number of WSLs changed in all groups. The highest number of WSLs increased in the Edgewise group compared to the control group. The average number of WSLs in the Edgewise group in the sixth month was 3.50 and increased in the eighth month to 5.88.

The mean number of *S. mutans* accumulations was lowest in Straightwire compared to the control group, and highest in the Edgewise group. The mean number of lesions accumulated by *S. mutans* changed in all groups. The highest accumulation of *S. mutans* bacteria increased in the Edgewise group compared to the control group of 23.38 x$10^5$ CFU/ml in the sixth month and increased to 54.50 x $10^5$ CFU/ml in the eighth month.

Data that had been tested for normality and homogeneity was eligible for parametric tests. The data was then analysed using the two-way ANOVA test to determine differences between groups in Table 2. The two-way ANOVA test results (Table 2) showed a significant difference in WSL scores in orthodontic treatment types, between observations ($p$<0.05) but not significant in the interaction of treatment types with observation time ($p$>0.05).

The test results showed no significant difference in the number of bacteria in the type of treatment and the interaction of the type of treatment with the time of observation ($p$> 0.05), but there were significant differences in the number of bacteria at the time of observation ($p$<0.05). Differences between groups in the two-way ANOVA test can be seen through the post-hoc LSD test (Table 3 and 4).

**Table 1.** Mean and standard deviations in the number of WSLs and accumulation of the sixth and eighth month *S. mutans* bacteria in the control, Edgewise, and Straightwire groups

| Variables | Group | 6th month | | 8th month | |
|---|---|---|---|---|---|
| | | *Mean* | SD | Mean | SD |
| Number of lesions | Control | 2.50 | 1.69 | 2.63 | 1.85 |
| | Edgewise | 3.50 | 2.00 | 5.88 | 1.64 |
| | Straightwire | 3.37 | 1.19 | 5.63 | 1.41 |
| Bacteria accumulation* | Control | 24.50* | 16.41* | 49.75* | 31.49* |
| | Edgewise | 23.38* | 20.60* | 54.50* | 32.44* |
| | Straightwire | 14.13* | 2.17* | 39.88* | 7.85* |

* bacterial unit in x$10^5$ CFU/ml

**Table 2.** Two-way ANOVA test for difference in increase in the number of WSLs and the accumulation of *S. mutans* between the three groups of treatment

| Variables | White spot lesion | | S. mutans | |
|---|---|---|---|---|
| | F | p-value | F | p-value |
| Treatment | 8.123 | 0.001* | 0.888 | 0.419 |
| Observation time | 11.035 | 0.002* | 32.553 | 0.000* |
| Treatment*Observation time | 2.346 | 0.108 | 0.354 | 0.704 |

* significant difference ($p$ <0.05)

**Table 3.** Post-hoc LSD test results difference in number of WSLs in the control group, Edgewise technique, Straightwire sixth and eighth month of treatment

| Groups | Control 6 | *Edgewise* 6 | Straight 6 | Control 8 | *Edgewise* 8 | Straight 8 |
|---|---|---|---|---|---|---|
| Control 6 | | 0.233 | 0.295 | 0.880 | 0.000* | 0.000* |
| *Edgewise* 6 | | | 0.880 | 0.295 | 0.006* | 0.014* |
| Straight 6 | | | | 0.369 | 0.004* | 0.009* |
| Control 8 | | | | | 0.000* | 0.001* |
| *Edgewise* 8 | | | | | | 0.764 |

* significant difference ($p$ <0.05)

**Table 4.** Post-hoc LSD test results on differences in the number of *S. Mutans* bacterial colonies in the control group, Edgewise technique, Straightwire sixth and eighth month of treatment

| Groups | Control6 | *Edgewise* 6 | Straight 6 | Control 8 | *Edgewise* 8 | Straight 8 |
|---|---|---|---|---|---|---|
| Control 6 | | 0.696 | 0.164 | 0.011* | 0.005* | 0.020* |
| *Edgewise* 6 | | | 0.311 | 0.004* | 0.002* | 0.007* |
| Straight 6 | | | | 0.000* | 0.000* | 0.000* |
| Control 8 | | | | | 0.734 | 0.812 |
| *Edgewise* 8 | | | | | | 0.564 |

* significant difference ($p$ <0.05)

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DOI: 10.20473/j.djmkg.v53.i3.p170–174

The post-hoc LSD test results (Table 3) on the incidence of WSLs found significant differences between the control group with Edgewise and Straightwire at the eighth month ($p$ <0.05) but not significant at the sixth month ($p$> 0.05). There was no significant difference between the Edgewise and Straightwire groups for the incidence of WSLs at six and eight months ($p$> 0.05).

The results of the post-hoc LSD bacterial test revealed no significant differences in the number of bacteria between the control, Edgewise and Straightwire groups in the sixth or eighth months ($p$> 0.05). The number of bacteria between times showed a significant difference between the sixth and eighth months in all control groups, Edgewise and Straightwire ($p$ <0.05). The highest in the eighth month Edgewise group compared to the sixth month Edgewise group. The Pearson's correlation test results found no significant relationship between the number of WSLs with the accumulation of *S. Mutans* bacteria that occurred in the control group, the Edgewise technique group or the Straightwire technique group ($p$> 0.05).

## DISCUSSION

The results of this study showed an increase in the number of WSLs occurred in the Edgewise and Straightwire groups compared to the control group. This indicated the influence of orthodontic treatment techniques on the accumulation of WSLs, where the control group had a lower risk of WSL growth compared to the Edgewise and Straightwire techniques. The increase in the number of WSLs was greater in the group treated with Edgewise and Straightwire techniques compared to the control group in line with the theory that risk factors were widely reported in fixed orthodontic appliance users – namely the increase in the amount of plaque retention due to the difficulty of cleaning and the limited self-cleansing mechanism in each individual.[18]

The differences in the number of WSLs grew over time in the Edgewise technique group more than in the Straightwire technique group although not significant at the sixth and eighth months. The Edgewise technique has a bracket design with a zero degree angulation angle that requires the use of wire bending to be able to produce resilience forces that can correct malpositioned teeth.[19] The bending of the wire to help tooth movement in the early stages and in several stages will affect the patient in maintaining oral hygiene, which results in food leftovers trapped in the bending of the wire, causing plaque retention and resulting in the formation of WSLs.[1] Research compared the sample of patients with orthodontic treatment using the Straightwire technique, which minimised the use of wire bending in the early stages of tooth correction so that it was easier for patients to clean the area of plaque retention from the effects of enamel demineralization that would become WSLs.[4]

Research conducted by Mayne et al.[20] which explained that the average increase in white lesions in patients occurs between four weeks to the first two months up to thirty-six months during treatment, which means within a period of two months during orthodontic treatment, the risk factor for WSLs can occur. This research began to be observed in the sixth month in the Edgewise and Straightwire groups because each technique contained a correction stage for dental malposition – namely the levelling and unravelling stages. The number of WSLs showed no significant difference between the Edgewise technique and the Straightwire technique in the sixth and eighth months, influenced by several important factors that cannot be avoided due to uncontrolled variables, such as dietary influence in each individual sample that cannot be equated – the type of food and the absence of precautions given to patients before orthodontic treatment was a separate concern that can be a possible trigger factor for the occurrence of WSLs.

There were differences in the amount of bacterial accumulation between the Edgewise technique group more than the Straightwire technique group, although not significant in the sixth and eighth months. This is in accordance with research conducted by Kanaya et al.[13] which explained that the accumulation of *S. mutans* bacteria can increase after the installation of orthodontic brackets at the initial stage, three months later. This situation is consistent with the results of research that with increased plaque retention in the oral cavity, bacterial accumulation increases and presents a risk of demineralization with the appearance of WSLs in the same time span.

In this study, we found no significant relationship between the number of WSLs with the accumulation of *S. mutans* bacteria that occurred in the control group, the Edgewise technique group or the Straightwire technique group. This is explained in a study conducted by Ranganath et al.[21] that WSLs can be reversible or irreversible, depending on the environmental conditions of the oral cavity of each individual related to the remineralization process involving salivary pH conditions, the ability of the host to regenerate cells and diet patterns. Based on the results of this study, it can be concluded that there was no significant difference in the number of WSLs and *S. mutans* between the Edgewise technique and the Straightwire technique and increasing the accumulation number of *S. mutans* bacteria. The number of *S. mutans* bacteria does not affect the relationship of the number of WSLs in the orthodontic treatment of the Edgewise and Straightwire techniques.

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