Journal of Contemporary Dental Sciences

Original Article

Correlation between Fixed Orthodontic Treatment and Dental Biofilm-Induced Gingivitis. A Cross-Sectional Study

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Access the journal online

Website:
https://jcds.qu.edu.sa/index.php/JCDS

e-ISSN: 1658-8207

PUBLISHER: Qassim University

ABSTRACT

Background: The relationship between periodontics and orthodontics is still debated, with fixed orthodontic appliances (FOA) creating challenges for oral hygiene and promoting the accumulation of bacterial plaque. FOA limits the ability to maintain good oral hygiene, potentially leading to temporary destructive periodontal processes. **Objectives:** Study the correlation between fixed orthodontic treatment and dental plaque-induced gingivitis by evaluating the periodontal status. **Materials and Methods:** The study investigated the relationship between FOA and periodontal status in 18 female participants. The following parameters were recorded for each patient: bleeding on probing, gingival index (GI), probing pocket depth (PPD), recession and enlargement of the gingiva, and plaque index (PI). **Results:** The results showed that the GI was significantly higher in the group with FOA compared to the group without FOA, indicating increased risk of gingival bleeding and inflammation. However, there was no significant difference between the two groups regarding approximate PI or PPD. The occurrence of gingival recession or enlargement was higher in the group with FOA, but not statistically significant. **Conclusion:** FOA may be associated with a higher risk of gingival inflammation, but further research with larger sample sizes is needed to confirm the findings. However, the study findings underscore the importance of maintaining good oral hygiene during orthodontic treatment to reduce the risk of periodontal complications.

Keywords: Dental biofilm, fixed orthodontic appliance, gingivitis, orthodontic treatment

Introduction

Orthodontic treatment has some unwanted side effects, among which are periodontal complications.[1] Periodontics-orthodontics interrelationship has been subject to a lot of investigation until today, and it is still a controversial issue.[2] The orthodontic treatment, however, requires the use of fixed brackets, metal wires, and certain other components, which inadvertently render tooth-cleaning cumbersome. Keeping a good oral hygiene while large areas are covered by the orthodontic appliance gets rather challenging at times.[3] Fixed orthodontic appliances (FOA) promote the accumulation of bacterial plaque because FOA limit the ability of patients to perform good oral hygiene, which can lead to temporary destructive periodontal processes.[4] Periodontal health is an important factor that may be used to evaluate the success of orthodontic therapy. Although treatment with FOA does not increase the levels of periodontal pathogens,[5] periodontal complications are reported to be one of the most common side effects linked to orthodontics.[6] FOA was associated with alveolar bone loss and increased periodontal pocket depths when compared to no orthodontic treatment.[7] Moreover, orthodontic patients' oral home care is inadequate and these patients are more prone to develop gingivitis during orthodontic treatment. Hence, oral hygiene instructions and a hygiene maintenance program should be taken seriously and strictly during the whole period of orthodontic treatment.[8] However, the aim of this study is to identify the correlation between fixed orthodontic treatment and dental plaque-induced gingivitis by evaluating the periodontal status.

Materials and Methods

Ethical approval

The study was registered by the Committee of Research Ethics, Deanship of Scientific Research, Qassim University; 2021 April, 17 (Code No. EA/6090/2021).

Study sample

A cross-sectional study included a sample of 18 female patients visiting the dental clinics of Qassim University Medical City. The sample is selected to be female only as a way to unify the hormonal profile and its effect on gingival and periodontal tissues. Participants' age was set to be 12–30 years old. Patients were divided into two groups: Group A: 9 participants with present FOA, and Group B: 9 participants with a history of FOA, but removed. The participants in group A were set to be using the FOA for at least 6 months and still having it fixed on their teeth. Meanwhile, participants of group B were set to be presented without their appliance, they finished their orthodontic treatment within a year, and are not having the FOA on their teeth anymore. All participants had a Declaration of Consent to participate in the study. Patients with a history of periodontitis, diseases that affect periodontal health, smoking, present or recent pregnancy were excluded from the study.

Data collection methods

The following periodontal parameters were recorded for each patient: Bleeding on probing (BOP), gingival index (GI),[9] probing pocket depth (PPD) [Figure 1], presence of recession [Figure 2] and enlargement of the gingiva [Figure 3], and finally plaque index (PI).[10] All parameters were recorded at 6 sites per tooth and percentages were calculated for each patient. After data were collected, all patients were given oral hygiene instructions and advised to practice tooth brushing twice daily.

GI by Loe and Silness:[9]
GI 0: Normal gingiva.
GI 1: Mild inflammation; slight change in color, slight edema. No BOP.
GI 2: Moderate inflammation; redness, edema, and glazing. BOP.
GI 3: Severe inflammation; marked redness and edema, ulceration. Tendency to spontaneous bleeding.

PI by Silness and Loe:[10]
PI 0: Absence of microbial plaque.
PI 1: Thin film of microbial plaque along the free gingival margin.
PI 2: Moderate accumulation with plaque in the sulcus.
PI 3: Large amount of plaque in sulcus or pocket along the free gingiva margin.

Figure 1: Bleeding on probing and probing pocket depth

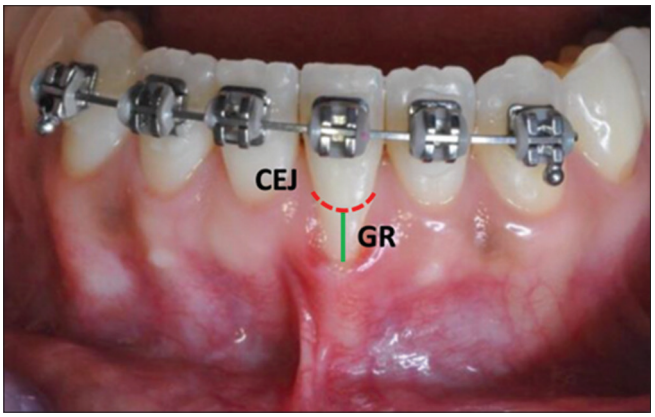

Figure 2: Tooth #31 with gingival recession;[11] red line is the Cemento-enamel junction, while the green line is the Gingival recession

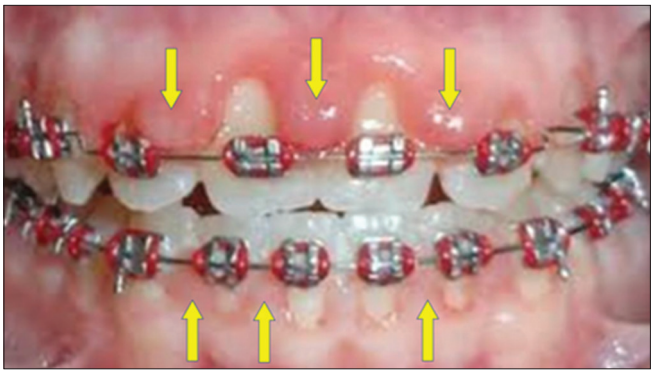

Figure 3: Upper and lower anterior teeth with gingival enlargement. The arrows point to enlarged interdental papillae.

Statistical analysis

Simple descriptive statistics of the orthodontic and periodontal status of the participants in the form of frequencies and percentages were calculated and tabulated. For quantitative variables, Means (M) and standard deviations (SDs) were reported as measures of central tendency and dispersion, respectively. For

comparison of qualitative variables, Fisher's exact test was applied and interpreted. For quantitative variables, the non-parametric Mann–Whitney U test was employed to compare the mean ranks across the two groups. Significance was established at a $P = 0.05$ or less with 95% confidence interval. All statistical calculations were performed using IBM SPSS version 27.0.1.

Results

Periodontal status of the participants

Table 1 presents descriptive statistics of the orthodontic treatment and periodontal status of the participants in the study. The sample consisted of 18 individuals, with 9 participants having FOA and 9 without FOA, making up 50% of the sample each. The GI had a mean score of 27.50 and a SD of 8.19 [Figure 4], indicating moderate to severe gingival inflammation in the sample. The approximate PI had a mean score of 15.83 and a SD of 8.04, suggesting that the participants had fair to poor oral hygiene. Regarding the recession or enlargement status, 22.2% of the sample had enlargement, 27.8% had recession, and the remaining 50% did not show any recession or enlargement. The mean PPD was 1.14 mm, indicating shallow pockets in the sample. The findings from Table 1 suggest that the participants had moderate to severe gingival inflammation, fair to poor oral hygiene, shallow pockets, and a mix of recession and enlargement. However, it is important to note that the sample size was relatively small, and the results may not be representative of the larger population. Further research with a larger sample is warranted to confirm these findings.

Table 1: Descriptive statistics of orthodontic and periodontal status of the participants

Variables	Count (n)	Percentage	Mean (M)	Standard deviation (SD)
Group				
With FOA[1]	9	50.0		
Without FOA[1]	9	50.0		
Gingival index			27.50	8.19
Plaque index			15.83	8.04
Gingival recession or enlargement				
Enlargement	4	22.2		
Recession	5	27.8		
Negative	9	50.0		
Probing pocket depth			1.14	0.13
Total	18	100.0		

[1]FOA: fixed orthodontic appliances

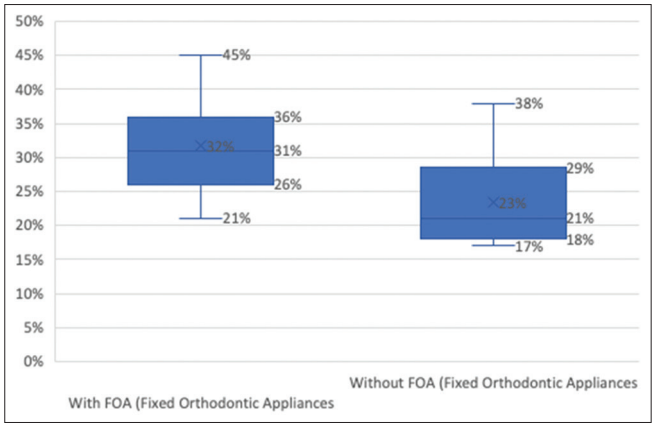

Figure 4: Comparison of gingival index across the two groups

Correlation between FOA and gingival health

The present study aimed to investigate the association of FOA with periodontal status. Table 2 presents the descriptive statistics and results of statistical tests performed to examine the association of FOA with GI, approximate PI, recession or enlargement, and PPD. The results showed that the bleeding index was significantly higher in the group with FOA compared to the group without FOA (M = 31.67, SD = 7.21 vs. M = 23.33, SD = 7.18, P = 0.019). However, no significant difference was found between the two groups regarding approximate PI (M = 18.33, SD = 9.01 vs. M = 13.33, SD = 6.48, P = 0.094) or PPD (M = 1.10, SD = 0.16 vs. M = 1.18, SD = 0.10, $P = 0.113$). Regarding gingival recession (GR) or enlargement, the participants with FOA had a higher percentage of enlargement compared to those without FOA (44.44% vs. 0.00%). In the group without FOA, 66.67% (n = 6) reported neither recession nor enlargement compared to only 33.33% (n = 3) in the group with FOA [Figure 5]. However, none of these differences were found to be statistically significant ($P = 0.136$).

Discussion

The results presented in Table 1 suggest that the participants in this study had moderate to severe gingival inflammation, fair to poor oral hygiene, shallow pockets, and a mix of recession and enlargement. These findings are consistent with other researches that had shown a strong relationship between orthodontic treatment and an increased risk of gingivitis and periodontitis.[2,12] It is because braces and other devices can make it tough to clean teeth and gums. Changes in the way teeth come together can put extra pressure on the gums, and changes in saliva flow can affect the balance of bacteria in the mouth. The use of FOA can make it more difficult

Table 2: Association of fixed orthodontic appliances with periodontal status

Gingival index	Group								*P*-value
	With FOA[I]				Without FOA[I]				
	M	SD	n	Category %	M	SD	n	Category %	
	31.67	7.21			23.33	7.18			0.019[U]
Approximate plaque index	18.33	9.01			13.33	6.48			0.094[U]
Gingival recession or enlargement									
Enlargement			4	44.44			0	0.00	0.136[F]
Recession			2	22.22			3	33.33	
Negative			3	33.33			6	66.67	
Probing pocket depth	1.10	0.16			1.18	0.10			0.113[U]

[I]FOA: Fixed orthodontic appliances, [U]: Mann–Whitney [U] test, [F]: Fisher's exact test, SD: Standard deviation. **P*<0.05, Significant

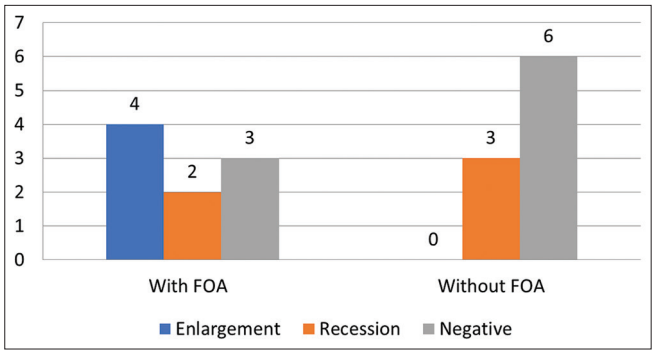

Figure 5: Comparison of gingival enlargement/recession across the two groups

for patients to maintain good oral hygiene, as plaque and food particles can easily become trapped around the brackets and wires.[13] This may explain the high PI score in the present study.

The finding of shallow pockets in this study is somewhat surprising, as the deepening of pockets is a common complication of periodontitis. However, it is important to note that the sample size was relatively small, and further research is needed to confirm this finding. The mix of recession and enlargement in the sample is also consistent with previous research that has shown that orthodontic treatment can lead to changes in the gingival contour.[14] Orthodontic treatment can lead to changes in the gingival contour because movement of teeth and changes in the position of the bone can cause the gums to shift and reshape.

The moderate to severe gingival inflammation observed in this study is a cause for concern, as it can lead to more serious periodontal disease if left untreated. Studies revealed plaque accumulation in orthodontic patients could be 2–3 times higher than plaque levels detected in high plaque-forming adults without FOA.[15] Thus, it is important for patients undergoing orthodontic treatment to maintain good oral hygiene and to receive regular dental check-ups to monitor their periodontal health. The use of interdental cleaning devices such as floss and interdental brushes, as well as antibacterial mouthwashes, can also be beneficial in reducing plaque accumulation and gingival inflammation.[16] It is beneficial in reducing plaque accumulation and gingival inflammation during orthodontic treatment by helping to clean hard-to-reach areas around the braces and wires. It is necessary to emphasize for orthodontic patients the importance of meticulous oral hygiene. Previous studies revealed poor orthodontic patients' awareness of their periodontal health.[17]

The present study aimed to investigate the association of FOA with periodontal status. The results of this study show that the GI was significantly higher in the group with FOA compared to the group without FOA. This finding is consistent with previous research, which has also reported an increase in bleeding index in patients with FOA.[4,18] A comparable study confirmed that visible plaque, visible inflammation, and GR showed significant increases after FOA treatment.[2] The GI increases in patients with FOA because the brackets and wires can make it more difficult to maintain good oral hygiene, leading to an accumulation of plaque and bacteria that can cause gum inflammation and bleeding. The higher GI may be attributed to the difficulty in maintaining good oral hygiene with fixed appliances, which can lead to the accumulation of plaque and the development of gingivitis.[19,20] The brackets and wires of the appliances can make it harder to clean teeth and gums properly, which can lead to an increase in the number of bacteria and the inflammation of the gums, resulting in bleeding. Therefore, it is important for patients with FOA to receive proper instructions on oral hygiene maintenance and to regularly visit their dentist for professional cleanings.

On the other hand, no significant difference was found between the two groups regarding approximate PI or PPD. This finding is in contrast to some previous studies

that reported an increase in plaque accumulation and PPD in patients with FOA.[21,22] It is due to difficulties in maintaining good oral hygiene with braces, leading to an accumulation of plaque and bacteria that can cause gum inflammation and pockets around the teeth. However, the present study had a relatively small sample size, which may have limited the ability to detect significant differences between the two groups. In addition, the duration of treatment and oral hygiene practices of the participants were not assessed, which may have influenced the results.

Regarding GR or enlargement, the present study found that the participants with FOA had a higher percentage of enlargement compared to those without FOA. However, this difference was not statistically significant. A previous study also reported an increase in gingival enlargement in patients with FOA.[23,24] It is due to the chronic irritation of the gum tissue, which can lead to an overgrowth of gum tissue and subsequent gingival enlargement. The cause of gingival enlargement may be multifactorial, and it may be influenced by the type of orthodontic appliance used, the duration of treatment, and the oral hygiene practices of the patient.[25,26]

Conclusion

FOA may be associated with a higher risk of gingival bleeding and inflammation, as evidenced by the significantly higher GI observed in the FOA group. However, there was no significant difference in plaque accumulation or PPD between the FOA and non-FOA groups. The study also found a higher occurrence of GR or enlargement in the FOA group, although this was not statistically significant. However, further research with larger sample sizes is needed to confirm these findings. Nevertheless, the outcome of the present study underscores the importance of maintaining good oral hygiene during orthodontic treatment to reduce the risk of periodontal complications.

Recommendations

The present study has a few potential limitations. The sample size is limited and the role of confounders such as oral hygiene habits, duration of FOA use, and socioeconomic status was not estimated. Larger sample size and better evaluation of confounders-related factors should be considered in further research projects to overcome the limitations of the present study.

Authors Contributions

All authors had equal contribution: Dr. Wesam Fathi: Conceptualization, methodology, validation writing – review and editing, supervision, project administration, and funding acquisition. Afrah Al-harbi: investigation, resources, writing – original draft preparation, and funding acquisition. Montaha Alsultan: Validation, formal analysis, data curation, visualization, and funding acquisition.

Funding

This research received no external funding.

Data Availability Statement

Authors agree to make data and materials supporting the results or analyses presented in this paper available upon reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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