Differences in Saliva pH of Users and Non-users of Fixed Orthodontic Wire in Dental Students (FKG UNPRI)

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A B S T R A C T

Fixed orthodontics corrects malocclusion, which can compromise facial aesthetics. Nevertheless, the utilization of this orthodontic apparatus presents the potential for plaque buildup stemming from the colonization of microorganisms, which may influence the pH of saliva. The purpose of the research was to compare the pH levels of the saliva of individuals who utilized fixed orthodontic wires to those who did not. The design of this survey-analytic, cross-sectional study is survey-based. Sixty-two FKG UNPRI students who satisfied the inclusion and exclusion criteria comprised the sample. We divided these students into two groups: one group utilized fixed orthodontic wires, while the other group did not. To determine the pH of saliva, submerge the pH paper tip into the saliva. If a color change occurs, modify the pH paper using a saliva pH indicator. Following the collection of all the data, an analysis of the data was conducted utilizing the Mann-Whitney statistical test. The study findings indicated that individuals who utilized fixed orthodontic wires had an average saliva pH of 6.16 ± 0.735, whereas those who did not use the devices had a saliva pH of 7.19 ± 0.543. According to the findings of the Mann-Whitney statistical test, a statistically significant distinction in saliva pH was observed between individuals who utilized fixed orthodontic wires and those who did not ($p = 0.000$; $p<0.05$). In conclusion, users of fixed orthodontic wires have, on average, a lower salivary pH than non-users.

1. Introduction

Despite the critical importance of dental and oral health to human life, public awareness of this remains extremely low. This has emerged as one of the detrimental factors affecting oral health, owing to the exorbitant expense, apprehension surrounding procedures, and parental reluctance to promote routine check-ups. One's physical appearance significantly influences their quality of life, social interaction, and communication. The primary focus of human communication is the individual's facial aspect. An appealing facial appearance can impart confidence to an individual. Nevertheless, there are various elements that contribute to an individual appearing less assured, including dental structure or malocclusion. Generally, individuals who have limited awareness regarding malocclusion or compromised dental structure will require oral cavity treatment. Orthodontic treatment is one effort that may support malocclusion. Malocclusion, a condition characterized by atypical occlusion or disturbance of craniofacial connections, has the potential to impact not only aesthetic appeal but also functional integrity, facial harmony, and psychosocial welfare.[1]

Orthodontic treatment treats malocclusion and may involve using fixed orthodontics for a duration of

18 to 36 months.[2] Fixed orthodontics have gained popularity among students as a means of addressing dental care concerns and improving appearance. There are some problems that might happen if you use fixed orthodontics. For example, it might be hard to brush your teeth, the pH level might drop, plaque buildup might get worse, and bacteria might stick to metal surfaces more easily because of electrostatic reactions.[3]

Orthodontic users have five times the normal level of *Lactobacillus* due to the plaque retention zones created by the appliances, which obstruct the tongue's natural ability to function as a barrier and remove food. In orthodontic treatment patients, the pH of their saliva decreases and becomes more acidic. Plaque contains a variety of acidogenic bacteria, with Streptococcus mutans and Lactobacillus in particular being present in high concentrations. Plaque pH decreases in patients as a result of the proliferation of microorganisms. Patients who underwent orthodontic treatment consequently encountered a more rapid progression of caries. Saliva's cleansing capacity and buffering strength diminish, consequently promoting the accumulation of dental plaque.[4]

Saliva, a biological fluid, can impact oral hygiene. Saliva does many things, such as making it easier for food to enter the mouth by acting as a lubricant, helping digestion with enzymes, building resistance, promoting tissue renewal with growth hormone, killing germs with immunoglobulin A (IgA), histatin, statherin, lyzozyme, and statherin, and keeping saliva pH safe with its buffer system. Saliva serves as a medium for microorganisms to store and convey themselves, a function that is contingent upon factors such as oral health status, bacterial quantity, and species. Furthermore, researchers hypothesize the presence of defense proteins and innate immune components. Secretory immunoglobulin A (sIgA), an important part of the salivary defense system, can react to changes in the oral microbiome while orthodontic treatment is going on.[6-11] Due to the complex structure of fixed orthodontics, orthodontic wire users should maintain a more hygienic oral environment and teeth. Patients can achieve this by regularly cleansing their teeth and undergoing oral cavity examinations throughout orthodontic treatment.

2. Methods

This study employs an analytical survey design and is cross-sectional in nature. The researchers conducted this investigation at Prima Indonesia University in North Sumatra from October to November 2023. We obtained the sample and population for this research through total sampling, which included 62 students. Among these, 31 were orthodontic wire users and 31 did not use wires; all participants met the inclusion criteria. We conducted the data analysis for this research using the Mann-Whitney instrument in computer-based SPSS.

3. Results and discussion

The sample with the greatest proportion of gender characteristics, as indicated in Table 1, consisted of 49 women (79.0%) and a mere 13 males (21.0%). With 25 participants (40.3%), the minimal age of the cohort was 21 years; only 2 participants (3.2%) fell within this age range. In accordance with semester categories, the findings of this study revealed that the largest proportion of samples (24 individuals, or 38.7%) occurred in semester 1. In contrast, semester 3 had the smallest sample size, with only four individuals (6.5%) collected.

Subsequently, Table 2 presents the research findings pertaining to the frequency distribution of individuals who utilized fixed orthodontic wires as samples. According to the findings outlined in Table 2, the proportion of individuals comprising the sample of users and non-users of fixed orthodontic wires was identical at 31 (50.0%) each. All research data underwent the Kolmogorov-Smirnov normality test and the Levene homogeneity test prior to the actual statistical analysis. The outcomes of these two tests indicated that the data exhibited homogeneity rather than a normal distribution. Consequently, we

employed the non-parametric Mann-Whitney test for data analysis.

Table 3 presents the research findings on the variations in saliva pH between individuals who have used fixed orthodontic wires and those who have not. The comprehensive Mann-Whitney statistical test results are available in Table 4.

Table 1. Participant characteristics.

Characteristics	n	%
Gender		
Male	13	21,0
Female	49	79,0
Age		
17	2	3,2
18	17	27,4
19	6	9,7
20	10	16,1
21	25	40,3
22	2	3,2
Semester		
1	24	38,7
3	4	6,5
5	11	17,7
7	23	37,1
Total	62	100,0

Table 2. Frequency distribution of fixed orthodontic wire users.

Users of fixed orthodontic wires	n	%
Yes	31	50,0
No	31	50,0
Total	62	100.0

Table 3. Saliva pH measurement results for users and non-users of fixed orthodontic wires.

pH	Orthodontic wire users	Non-orthodontic wires users
5	6 people	-
6	14 people	2 people
7	11 people	21 people
8	-	8 people
Total	31 people	31 people

Table 4. Differences in salivary pH from users and non-users of fixed orthodontic wires.

Users of fixed orthodontic wires	Salivary pH	p-value
	Mean±SD	
Yes	6.16±0.735	0.000*
No	7.19±0.543	

Note : Mann-Whitney; *Significant value.

The calculation results presented in Table 3 indicate that the mean saliva pH of individuals who utilize fixed orthodontic wires is 6.16 ± 0.735, whereas the pH of the saliva of non-users is 7.19 ± 0.543. The Mann-Whitney test yielded a p-value of 0.000 ($p<0.05$), indicating that there was a statistically significant distinction in saliva pH between individuals who utilized fixed orthodontic wires and those who did not.

Researchers conducted this study on 62 samples, with 31 patients having fixed orthodontic wires and 31 patients without fixed orthodontic wires, to determine differences in saliva pH. Saliva serves as a crucial constituent in regulating the internal environment of the cavity.[12] However, salivary pH varies among individuals for a variety of reasons, including

mechanical stimulation experienced by those who wear fixed orthodontic wires.[4]

The study's findings revealed that individuals who utilized fixed orthodontic wires had a mean salivary pH of 6.16 ± 0.735, which was significantly lower than the salivary pH of non-users (7.19 ± 0.543). Contrary to the findings of Erliera et al., the present study reveals that patients undergoing fixed orthodontic wire treatment had a higher pH of saliva than those without such wires.[4] Furthermore, these findings are in opposition to those of prior investigations. Carrillo et al. detected an elevation in saliva pH among individuals who utilized fixed orthodontic wires.[2] This study's findings may differ from those of previous research due to the composition of the research samples; this study focused on general students without examining their habits, whereas previous research examined specific habits such as smoking and delectable food consumption. Therefore, variations in the characteristics of the samples under investigation may be influenced, resulting in disparate outcomes.

Good oral hygiene significantly impacts oral health, especially for patients with fixed orthodontics. This is due to the fact that fixed orthodontic wires may increase the risk of periodontal disease, dental lesions, root resorption, TMJ dysfunction, and masticatory disorders, as well as impede effective oral hygiene.[11] As a consequence of increased plaque accumulation and appliance retention, the group that utilized orthodontic wires exhibited a lower plaque pH. Conversely, the group that did not employ fixed orthodontic wires exhibited a distinct plaque pH value.[7,9,13]

The homogeneity of all research data was assessed using the Kolmogorov-Smirnov and Levene tests. The findings of these two tests indicated that the data were not normally distributed but were homogeneous. Therefore, we utilized the Mann-Whitney non-parametric test to analyze the data. As a result, it was possible to conclude that there was a significant difference in saliva pH between individuals who utilized fixed orthodontic wires and those who did not,

with a p-value of 0.000 (p<0.05). Previous study supports the findings of this study, indicating a significant distinction in plaque pH between individuals who have utilized fixed orthodontic wires and those who have not.[10]

Variations in the pH of dental plaque within the oral cavity significantly influence the processes of remineralization and demineralization that occur in the course of caries formation and bacterial proliferation.[13,14] The findings of this research indicate that the salivary pH of the group utilizing fixed orthodontic wires was acidic, in contrast to the alkaline pH of the group that did not use such wires. This finding indicates that individuals who wear fixed orthodontic wires may observe a reduction in saliva pH, which increases the likelihood of compromised oral hygiene and subsequent dental and oral health complications such as gingivitis and caries. This finding contradicts the findings of Oktaviani and Santoso, who concluded that despite the fact that the group utilizing fixed orthodontic wires had a lower plaque pH, it remained within acceptable limits and thus did not lead to the development of cavities.[10]

Routine control is of utmost importance in preserving the hygiene of an individual's buccal cavity. Once per month, individuals who are using fixed orthodontic wires should perform routine oral hygiene exams. Food particles are more likely to accumulate on the teeth when orthodontic appliances are present in the mouth. Additionally, individuals must regularly remove tartar from the appliances using a specialized toothbrush.[3,8,15] The use of fixed orthodontic wires is a risk factor for accelerated plaque accumulation, which ultimately results in tooth caries.[3] Due to inadequate oral hygiene, protracted oral examinations may impede the detection of gingivitis or tooth erosion, thereby potentially exacerbating the condition.[10]

4. Conclusion

The findings of the conducted research support the conclusion that there exists a statistically significant disparity in the saliva pH levels between individuals who wear fixed orthodontic wires and

those who do not. The salivary pH of individuals who utilize fixed orthodontic wires is on average lower than that of those who do not.

5. References

1. Al-Haifi, Abdullah HA, Ishaq RAA, Al-Hammadi MSA. Salivary pH changes under the effect of stainless steel versus elastomeric ligatures in fixed ortodontic patients: a single-center, randomized controlled clinical trial. BMC Oral Health. 2021;21(1):1–7.

2. Carrillo EL, Bastida NMM, Pérez LS, Tavira JA. Effect of ortodontic treatment on saliva, plaque and the levels of Streptococcus mutans and Lactobacillus. Med Oral Patol Oral Cir Bucal. 2010;15(6):924-9.

3. Choi YY. Relationship between orthodontic treatment and dental caries: results from a national survey. Int Dental J. 2020;70:38–44.

4. Erliera, Nurdiana, Triastuti MI. Differences of salivary flow rate and ph between fixed orthodontic patient and non-orthodontic patient of USU dental students. Dentika. 2016;19(1):66-70.

5. Jing D, Hao J, Shen Y, Tang G, Lei L, et al. Effect of fixed ortodontic treatment on oral microbiota and salivary proteins. Exp Ther Med. 2019;17(5):4237–43.

6. Kouvelis G, Papadimitriou A, Merakou K, Doulis I, Karapsias S, et al. A prospective cohort study assessing the impact of fixed orthodontic appliances on saliva properties and oral microbial flora. Oral Health Prev Dent. 2021;19(1):67–76.

7. Kozak U, Lasota A, Chalas R. Changes in distribution of dental biofilm after insertion of fixed orthodontic appliances. J Clin Med. 2021;10;1-10.

8. Meiandari S, Taadi T, Widayati A. The relation between pain after using fixed orthodontic appliance and follow-up compliance of patients in Kusuma Dental Care Clinic. J Kesehatan Gigi. 2020;7(1):35–9.

9. Mulimani P, Popowics T. Effect of orthodontic appliances on the oral environment and microbiome. Front Dent Med. 2022;3(924835):1-11.

10. Oktaviani V, Santoso, O. Differences in Oral Hygiene Index and Plaque pH in Users and Non-Users of Fixed Orthodontic Planes. J Kedokteran Diponegoro 2016;5(1): 50-57.

11. Perkowski K, Baltaza W, Conn DB, Marczynska-Stolarek M, Chomicz L. Examination of oral biofilm microbiota in patients using fixed orthodontic appliances in order to prevent risk factors for health complications. Ann Agric Environ Med.2019; 26:231–35.

12. Puti IRS, Widyasari R, Putri NDA. Case Report on the relationship between less optimal sleep hours and salivary flow rates in coassistant doctors. J Kedokteran Gigi Universitas Padjajaran. 2020; 32(3): 220-25.

13. Putri MH, Herijulianti E, Nurjannah N. Science of prevention of hard tissue diseases and dental supporting tissues. Jakarta: EGC. 2011.

14. Wirawan E, Puspita S. Relationship between salivary pH and buffering ability with DMF-T and def-t in the mixed teeth period of children aged 6-12 years. Insisiva. 2017;6(1).

15. Zou J, Meng M,. Law CS, Rao Y, Zhou X. Common dental diseases in children and malocclusion. Int J Oral Sci. 2018;10(1):1-7.