CHANGES IN SALIVARY FUNCTION AFTER PLACEMENT OF FIXED ORTHODONTIC APPLIANCES

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Abstract

Objective: To determine the physiologic changes in the salivary pH and salivary buffer capacity in patients undergoing fixed orthodontic treatment.

Materials and Methods: The study included 70 patients scheduled for fixed orthodontic therapy. Unstimulated saliva samples were taken before placement of the appliance(T0) and at 1 month (T1),3 months(T2) and 6 months(T3) during the therapy. Saliva-Check BUFFER kit from GC India Dental Pvt Ltd, India was used to check salivary pH and buffer capacity at these time periods.

Results: No statistically significant difference was seen in pH values between the different time periods. No significant difference in the buffering capacity was seen between T0 and T1, but a statistically significant difference is present between the values at T0 and T2 as well as T0 and T3. Even the values at T1 were significantly different fom T2 and T3.

Conclusion: Orthodontic treatment changes the oral environmental factors and promotes an increase in buffer capacity of the saliva which increases the anticaries activity of saliva.

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Introduction

Orthodontic treatment is carried out by bonding attachments, mainly brackets to the tooth surface for the purpose of causing desired tooth movement. The fixed orthodontic appliances not only make oral hygiene maintenance more difficult but also provide plaque retention sites on surfaces of the teeth that are normally less susceptible to caries development.[1]

A rapid shift in the bacterial flora of plaque is seen after the introduction of fixed orthodontic appliances into the oral cavity. Higher levels of acidogenic bacteria such as S. mutans and Lactobacilli are present in the plaque.[2] These high levels of acidogenic bacteria are capable of decreasing the pH of plaque in orthodontic patients.[3]

Saliva plays an important role on caries development because of its participation in the dilution of substances in the oral cavity, mechanical cleansing, post-eruptive maturation, demineralization and remineralization of dental enamel, pellicle formation, antimicrobial action and buffering of acids produced by biofilm and foods.[4,5,6]

It is postulated that the balance between the cariogenic challenge posed by high levels of S. mutans and lactobacilli causes a concurrent increase in salivary flow rate, pH and buffer capacity of saliva and these reparative effects, determine the likelihood of mineral loss or gain over time.[7] The protective characteristics of saliva against caries are a result of the salivary flow, of its buffering capacity and of its calcium and phosphate concentrations and several antibacterial systems.

The evaluation of the risk of developing caries or forming dental calculi depends on the salivary composition of each individual. These diseases may lead to serious complications for the patient and may put at risk the esthetic, functional and health benefits of orthodontic treatments, requiring a premature removal of the appliances. Therefore, the characteristics of saliva of individuals under treatment using fixed orthodontic appliances should be studied.[8]

Many methods are available to assess carious lesions in the teeth. Compared to visual inspection, the use of DIAGNOdent provides a more objective and reproducible method to assess the presence of white spot lesions. The DIAGNOdent is sensitive enough to detect initial carious lesions in smooth enamel surfaces and it could be a valuable tool to longitudinally monitor the progression of enamel decalcifications during fixed orthodontic treatment because of its ease of use in a clinical setting.[9]

Patients experience changes in saliva over time, and these changes have a long-term clinical significance.[10] Studies have detected associations between fixed orthodontic appliances, microbial outcomes and measures of salivary function but the results are not consistent. Hence this study was done to determine how the salivary function adjusts to new intraoral circumstances, such as placement of fixed orthodontic appliances and also to evaluate the influence of saliva as a predisposing factor for white spot lesions.

Materials and Method

Patients were screened at the Department of Orthodontics & Dentofacial Orthopedics, at SRM Kattankulathur Dental College & hospital, and Seventy (70) patients who fulfilled the inclusion criteria were selected for the study. The participants and their legal guardians were informed about the purpose of the study, and informed consent was obtained. Saliva-Check BUFFER kit from GC India Dental Pvt Ltd, India was used to check salivary pH and buffer capacity.

Materials used for collecting and testing saliva included:-

1. Salivary collection cup (GC India Dental Pvt Ltd, India) (Figure 1).
2. Saliva Check Buffer Test Strip (GC India Dental Pvt Ltd, India) (Figure 2) for measurement of salivary buffering capacity.
3. Saliva Check test (GC India Dental Pvt Ltd, India) (Figure 3) for measurement of salivary pH.

Figure 1. Salivary collection cup

Figure 2. Saliva Check Buffer Test Strips

Figure 3. pH measuring strips

The unstimulated saliva of the patient was collected and measured for the salivary pH and buffering capacity before the start of the treatment (T0). The patient was asked to expectorate pooled saliva in the mouth into the collection cup. The pH test strip was taken and placed into the sample of resting saliva for 10 seconds.(Figure 4) The change in the colour of the strip was compared with the testing chart available (figure 5), and the value indicated by the color was recorded as the pH for the patient.

Figure 4. pH strip placed in patient's saliva

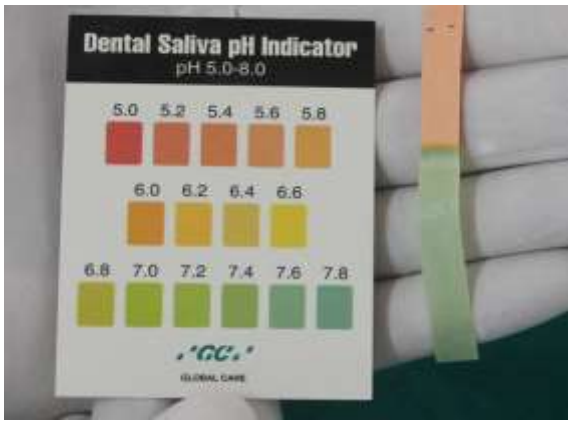

Figure 5. pH indicator chart

For measurement of buffering capacity, a Buffer test strip was removed from the foil packing and placed onto an absorbent tissue with test side facing up. Using a pipette, sufficient saliva was drawn from the collection cup and one drop of saliva was dispensed onto the 3 test pads.(Figure 6) The strip was turned 90° to soak up excess saliva on the absorbent tissue. The test pads changed colour and after 2 minutes the final result was calculated by adding the points according to the final colour of each pad using a conversion table supplied in the kit by the manufacturer.(Figure 7)

Figure 6. Testing of buffering capacity of saliva

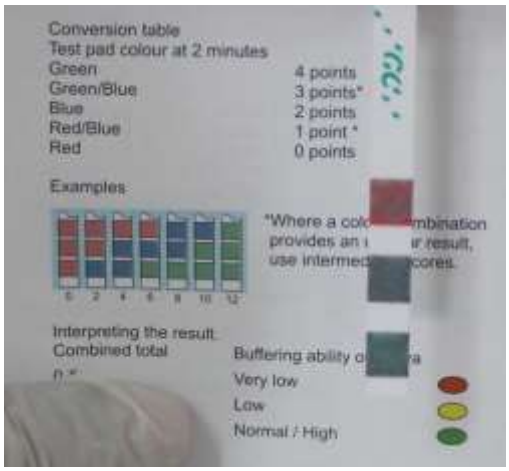

Figure 7. Buffering capacity conversion table

The DIAGNOdent pen was used to assess enamel decalcification on the tooth surface. Measurements provided the actual reading of the spot that was currently being measured (moment) as well as a peak reading over the selected area (Figure 8). The peak measurement for each tooth was recorded as measurement of the most decalcified enamel.

Figure 8. DIAGNOdent pen with the display panel showing the peak and the actual moment measurement

The patients were reviewed after 1 month (T1), 3 months (T2) and 6months (T3) and the patient's saliva was collected at T1, T2 & T3 for measurement of salivay pH & buffering capacity.

The DIAGNOdent readings were also recoded to evaluate the decalcification of enamel around the brackets. Figure 9 shows the evaluation of DIAGNOdent reading in a patient.

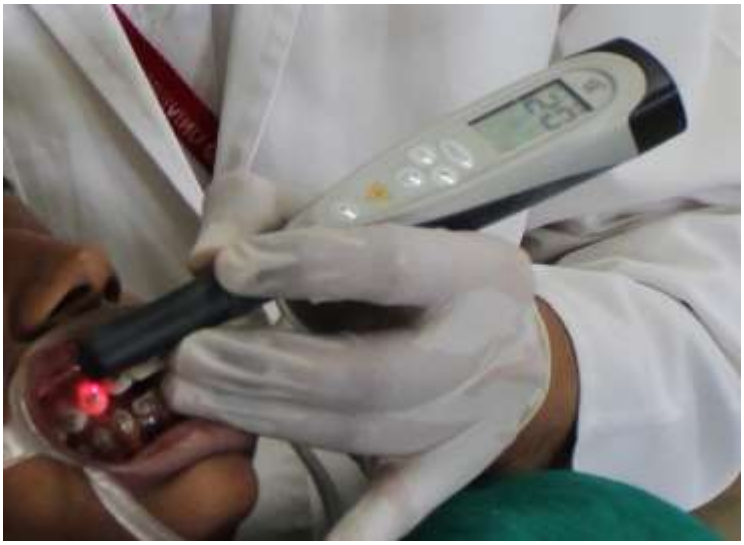

Figure 9. Recording of DIAGNOdent value in the patient

Results and Statistical Analysis

The values obtained from the experiment were tabulated in microsoft excel format and Repeated measures ANOVA and Post hoc Bonferroni analysis were done to obtain the results.

At T0 all the patients had salivary pH in the range of 6.8 to 7.8, which corresponds to the values indicating healthy saliva. During the course of treatment (T1,T2,T3) the increase in value of the pH corresponded to the increase in the DIAGNOdent values suggesting enamel demineralization. Table 1 shows the mean values for pH at different time intervals.

Time frame	Mean	Std. Deviation	N
T0 (Pre -op)	7.47	.503	70
T1 (1 month)	7.43	.498	70
T2 (3 months)	7.51	.503	70
T3 (6 months)	7.44	.500	70

Table 1. Mean Values for pH at different time intervals

Table 2. Pairwise Comparisons of pH at different time intervals

Factor (I) (Time period 1)	Factor 2(J) (Time period 2)	Mean ifference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a]	
					Lower Bound	Upper Bound
T0	T1	.043	.043	1.000	-.074	.159
	T2	-.043	.055	1.000	-.194	.108

	T3	.029	.057	1.000	-.127	.185
	T0	-.043	.043	1.000	-.159	.074
T1	T2	-.086	.034	.079	-.177	.006
	T3	-.014	.052	1.000	-.155	.127
	T0	.043	.055	1.000	-.108	.194
T2	T1	.086	.034	.079	-.006	.177
	T3	.071	.051	1.000	-.068	.210
	T0	-.029	.057	1.000	-.185	.127
T3	T1	.014	.052	1.000	-.127	.155
	T2	-.071	.051	1.000	-.210	.068

The mean difference is significant at the .05 level.
a. Adjustment for multiple comparisons: Bonferroni.

Pairwise comparisons of pH at different time intervals are shown in Table 2 which shows no statistically significant difference in pH values between the time periods.

At T0 the buffering capacity differed from patient to patient with a wide range starting from 4(very low) to 12(high). The buffering capacity either remained the same throughout study duration or increased in value. The increase in value corresponded with the increase in the DIAGNOdent values. Table 3 shows the mean values for buffering capacity at different time intervals.

Time frame	Mean	Std. Deviation	N
T0 (Pre -op)	7.56	2.320	70
T1 (1 month)	7.76	2.312	70
T2 (3 months)	8.34	1.817	70
T3 (6 months)	8.27	1.888	70

Table 3. Mean Values for Buffering capacity at different time intervals

Table 4. Pairwise Comparisons of Buffering capacity at different time intervals

Factor 1(I) (Time period 1)	Factor 2(J) (Time period 2)	Mean Difference (I-J)	Std. Error	P value	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
	T1	-.200	.154	1.000	-.620	.220
T0	T2	-.786*	.147	.000	-1.184	-.388
	T3	-.714*	.150	.000	-1.121	-.308
	T0	.200	.154	1.000	-.220	.620
T1	T2	-.586*	.118	.000	-.906	-.266
	T3	-.514*	.145	.004	-.908	-.121
	T0	.786*	.147	.000	.388	1.184
T2	T1	.586*	.118	.000	.266	.906
	T3	.071	.108	1.000	-.223	.366
	T0	.714*	.150	.000	.308	1.121
T3	T1	.514*	.145	.004	.121	.908
	T2	-.071	.108	1.000	-.366	.223

*. The mean difference is significant at the .05 level.
b. Adjustment for multiple comparisons: Bonferroni.

Pairwise comparisons of buffering capacity at different time intervals are shown in Table 4. It shows that there is no significant difference between T0 and T1, but a statistically significant difference is present between the values at T0 and T2 as well as T0 and T3. Even the values at T1 are significantly different fom T2 and T3.

Discussion

The fixed orthodontic appliance provide areas for the adhesion of oral bacteria and prevents proper cleaning and removal of plaque. The volume of dental plaque rapidly increases after placement of fixed orthodontic appliances, moreover there is a change in bacterial flora in the plaque. There is an increase in the levels of Streptococcus mutans and Lactobacilli. These acidogenic bacteria decrease the plaque pH which hinder the remineralization process.[2,7]

Studies have been conducted to determine the effects of fixed orthodontic appliances on salivary properties but no consensus has been achieved in the literature on how the orthodontic treatment may alter the composition of saliva and influence caries incidence.[12] It is known that after exposure of the oral environment to a cariogenic challenge, the pH of dental biofilm decreases but, afterward, it returns to the resting level mainly because of the phosphate and carbonate pH buffering capacity of saliva.[13] As saliva provides a general protective effect, clinically significant changes in salivary properties may be considered an etiologic factor that contributes and modulate the development and the prevention of dental caries.[14]

In our study, no statistically significant changes were observed in the salivary pH during the observation period. This is in correlation with the findings of Alessandri Bonetti et al who found no significant difference in stimulated flow rate and salivary pH in their study.[15] These results are in contradiction to the findings of Chang et al who found that there was a statistically significant increase in stimulated salivary flow rate and pH after three months of active treatment.[7] Some studies also show opposite results like the findings of Kanaya et al. denoted that salivary pH decreased during orthodontic treatment.[14] Hellen et al[8] also found a reduction in salivary pH during fixed appliance therapy. Significant reductions in the salivary flow rate and pH were noted by Alshahrani et al[17] as well, 2 months after commencing treatment.

The findings of Sanpei et al.[16] found no changes in salivary flow rates and buffer capacity during and after active orthodontic treatment. Alessandri Bonetti et al[15] also found no significant difference in buffer capacity during orthodontic treatment. Moreover significant reductions in the salivary buffering capacity were noted by Alshahrani et al[17] 2 months after commencing orthodontic treatment. Hellen et al[8] also found a reduction in buffering capacity and an increase in the concentration of calcium ions and concluded that these oral changes are enough to cause tooth demineralization.

In this study, there was a statistically significant increase in the buffer capacity of saliva of the patients at 3rd and 6th month of orthodontic treatment. These results were in correlation with the results of Chang et al.[7] who also found an increase in salivary buffer capacity after 3 months of active treatment.

The salivary pH and buffer capacity differed from patient to patient. The value for both these investigations either remained the same for a particular patient throughout the study period or in some patients it increased with increase in demineralization of the enamel. The buffer capacity significantly increased at 3rd and 6th month of orthodontic treatment, this suggests that the response of the patients to fixed orthodontic appliance is highly variable and differs for individual patient. However the increase in value with increase in demineralization suggest that patient is responding to the acidogenic environment, which is created by the appliance, and is compensating for this increased acid content by increasing the buffering capacity of the saliva to prevent enamel demineralization.

Another important result was that the pH and buffering capacity of the saliva does not dictate the response of the patient to enamel demineralization during orthodontic appliance therapy. The patients with low pH and low buffering capacity did not necessarily show more amount of decalcification and patients with high pH and high buffering capacity didn't necessarily show less amount of decalcification. This suggests that balance between demineralization and remineralization of enamel surface is maintained according to the oral environment of the patient.

Salivary pH and buffering capacity are not the sole factors responsible for controlling demineralization in orthodontic patients. Salivary flow rate, nutritional status and oral hygiene maintainence also affect caries development in patients. Hence patients with orthodontic appliances should adopt to additional oral hygiene procedures.

Conclusion

The changes in salivary pH and buffer capacity differed from patient to patient. Homeostasis between demineralization and remineralization of enamel surface is maintained according to the oral

environment of the patient. Orthodontic treatment changes the oral environmental factors and promotes increase in buffer capacity which increases the anticaries activity of saliva demonstrating the physiologic response to maintain the oral health in adverse situations.

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