ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 5, October - 2020, Page No. : 430 - 436

Changes in salivary flow rate, salivary pH, and buffer capacity in healthy patients during fixed orthodontic therapy.

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Citation of this Article: Dr. Sarvesh P Agrawal, Dr. Siddharth Shetty, Dr.Subraya Mogra, Dr. Nidhin Philip Jose, Dr Reema Agrawal,"Changes in salivary flow rate, salivary pH, and buffer capacity in healthy patients during fixed orthodontic therapy", IJDSIR- October - 2020, Vol. – 3, Issue - 5, P. No. 430 – 436.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction: Salivary properties play a vital role during orthodontic treatment with fixed appliances with respect to plaque retention, oral hygiene maintenance and dental caries susceptibility. This study was planned to determine the changes in salivary flow rate, salivary pH, and buffer capacity in healthy patients before and during therapy with fixed orthodontic appliances.

Material and Methods: This was a longitudinal study including 20 healthy subjects in the age group of 12-25 years undergoing fixed orthodontic therapy. Salivary samples were collected 2 to 4 weeks before and at 6, 12, and 18 weeks after placement of fixed orthodontic appliances. Salivary flow rate, salivary pH and salivary buffering capacity were measured. The statistical tests used were ANOVA, Pearson correlation coefficient and post-hoc.

Results: The mean salivary flow rate recorded at baseline, at 6, 12 and 18 weeks was 1.30, 1.48, 1.64 and 1.77 respectively. The mean salivary pH at baseline reading, at 6, 12, and 18 weeks was 7.15, 7.16, 7.11 and 7.18 respectively. The mean salivary buffering readings at baseline, at 6, 12 and 18 weeks were 7.46, 7.38, 7.50 and 7.86. There was no significant correlation between

salivary flow rate, salivary pH and salivary flow rate at any of the given time interval.

Conclusion: Orthodontic treatment changes the oral environmental factors increases the salivary flow rate, also there is increase in salivary pH over time as well as an increase in salivary buffering capacity, showing increase in the anti caries activity of saliva, but this increase is statistically not significant.

Key words: Fixed Orthodontic Appliances, Saliva, Salivary flow rate, salivary pH, Buffer capacity.

Introduction

Salivary properties during fixed orthodontic therapy influence the plaque retention, oral hygiene maintenance, bacterial colonization, white spot formation and dental caries susceptibility. Wearing orthodontic appliances has been known to induce intraoral changes, such as increased plaque accumulation and elevated bacterial colonization along with potential enamel demineralization and a harmful effect on periodontal tissues[1]. Intraoral environmental change leads to an increase in the volume and number of bacteria within dental plaque[2] and may shift a healthy bacterial community to one that is able to cause disease[3]. However, several studies of interactions among orthodontic material, microorganisms, and saliva have not detected associations between orthodontic appliances and clinical and microbial outcomes[4-7].

It is important to determine how the salivary functions adjust to placement of fixed orthodontic appliances. Hence this study was designed to detect any associations between fixed orthodontic appliances, and the physiologic changes of salivary flow rate, salivary pH, and buffer capacity in healthy patients before and during therapy with fixed orthodontic appliance.

Materials and Methods

This is a longitudinal study for which 20 subjects in the age group of 12-25 years that were undergoing fixed orthodontic therapy in the department of orthodontics were selected. An informed consent was obtained from each participant. The study was conducted after getting clearance from 'Institutional Ethical Committee'.

The inclusion criteria consisted of healthy patients in the age group of 12-25 years undergoing fixed orthodontic therapy with all permanent teeth erupted and mild to moderate crowding. Patients diagnosed with systemic illness, syndrome or on prolonged prescribed medication or on antibiotic therapy were excluded from the study. Patients suffering from periodontitis prior to undergoing orthodontic treatment were also excluded.

All subjects received fixed orthodontic therapy using bands, brackets, tubes, bonded with same adhesive material without fluoride to avoid chemical or metallic discrepancies. A Blue light source with wavelength of 470 nanometer was used for polymerization (applied for 20 seconds per brackets). For salivary analysis a bench top pH meter was used. For periodontal examination William's graduated periodontal probe was used.

Method of Saliva Collection-

Salivary samples were collected 2 to 4 weeks before fixed appliance treatment for baseline assessment between 10am to 11am. Subjects were instructed not to eat or drink for at least one hour before sample collection. Subjects were given a standardized piece of paraffin wax to chew and the stimulated saliva was collected by having the subject spit for 10 minutes into a sterile plastic graduated cup with 1 ml gradation marks.

Salivary Analysis

Collected salivary volume was measured in milliliters and the salivary flow rate was calculated based on collection time of 10 minute and expressed as ml/minute.

Sterile Plastic cup containing 10 ml of saliva was kept stable 30 to 60 minutes after its collection at room temperature. pH and buffer capacity were recorded by

using a bench top digital pH meter that incorporated automatic temperature compensation.

Salivary pH: The glass electrode of the pH meter was kept dipped in a beaker containing double distilled water having a pH of 7.2.The pH meter was then calibrated at pH 4 and pH 7 at 37◦C. Once the pH meter is calibrated the electrode is washed thoroughly with distilled water, dried and placed in beaker containing 10 ml saliva sample. The electrode should not touch any part of the glass beaker. The regulator of pH meter is turned from neutral position to pH position. The reading will fluctuate for 45 – 60 seconds. Then the digital reading comes to a halt, which is the accurate pH of the sample.

Salivary Buffering Capacity: 0.5 ml acetic acid of 0.1M concentration is added to 10 ml of saliva. The electrode is removed, washed, dried and placed in the beaker containing saliva. The pH change is calculated by subtracting the treated salivary pH from the first salivary pH. Salivary buffer capacity will be calculated according to buffer capacity formula as:

Buffering capacity $=-\Delta n(acid) /(V1*\Delta pH)$

Where,

$-\Delta n(acid)$- is the amount of acid added

V1- is the volume of saliva

ΔpH- is the pH change induced by adding acid

Salivary samples were taken at 6, 12, and 18 weeks after placement of fixed orthodontic appliances in a similar way as described above.

Statistical Analysis

Percentage distribution of the data like age and gender was evaluated using descriptive statistics. The data was recorded at baseline and at 6th week, 12th week and 18th week of fixed orthodontic therapy. The comparison between the data obtained for the various parameters of the study viz. salivary flow rate, salivary pH and salivary buffering capacity at different intervals was done using ANOVA test. $P< 0.05$ was considered statistically significant. To further study the pair-wise comparisons in each parameter at different intervals Post Hoc test was used. To determine correlation between the parameters Pearson correlation coefficient was done. Statistical tests were done using SPSS 18.0 (Statistical Package for Social Sciences).

Results

The total sample size was 20 patients. The age of the selected patients was in the range of 15-25 years. 50% of the patients were in the age group of 16-20 years, 35% in the age group of 21-25 years and 15% in the age group of 12-15 years. Among the 20 patients there were 11 (55%) females and 9 (45%) males. The salivary flow rate recorded at baseline, at 6 weeks interval, at 12 weeks and 18 weeks (Table 1). The minimum reading was noted at baseline interval and maximum at 18 weeks interval. The salivary flow rate at all intervals was assessed using ANOVA showing high statistically significant difference ($P<0.05$). Post Hoc was done to evaluate the pair-wise comparisons in salivary flow rate at different intervals. (Table 2)

Table 1: Range, Mean, and Standard deviation for Salivary Flow rate

Intervals	N	Minimum	Maximum	Mean	Std. Deviation	Median	p value	95% confidence interval	
								Lower bound	Upper Bound
BASELINE	20	0.70	2.00	1.30	0.35	1.20	0.00*	0.61	1.98
6 WEEKS	20	0.80	1.80	1.48	0.32	1.50		0.85	2.10
12 WEEKS	20	1.20	2.00	1.64	0.24	1.65		1.16	2.11
18 WEEKS	20	1.50	2.20	1.77	0.25	1.80		1.28	2.26

*- High significant difference (P<0.05)

Table 2: Pair-wise comparisons among intervals for Salivary Flow rate

(I) factor1	(J) factor1	Mean Difference (I-J)	Std. Error	change (%)	pvalue	
BASELINEREADING	AT6WEEKS	-.185	.058	14.29	.028	sig
	AT12WEEKS	-.340	.076	26.25	.001	HS
	AT18WEEKS	-.470	.087	36.29	.000	HS
AT6WEEKS	AT12WEEKS	-.155	.054	10.47	.056	
	AT18WEEKS	-.285	.068	19.26	.003	HS
AT12WEEKS	AT18WEEKS	-.130	.055	7.95	.178	

HS- High significant difference (P<0.05)

Table 3: Range, Mean, and Standard deviation for salivary pH

Intervals	N	Minimum	Maximum	Mean	Std. Deviation	Median	p value	95% confidence interval	
								Lower bound	Upper bound
BASELINE	20	6.08	8.20	7.15	.58	7.20	0.65	6.01	8.28
AT 6 WEEKS	20	6.30	8.00	7.16	.45	7.20	NS*	6.27	8.04
AT 12 WEEKS	20	6.40	8.00	7.11	.45	7.20		6.22	7.99
AT 18 WEEKS	20	6.50	7.80	7.18	.39	7.35		6.41	7.94

* NS- Non- significant statistical difference (P>0.05)

Table 4: Range, Mean, and Standard deviation for salivary buffering capacity

Intervals	N	Minimum	Maximum	Mean	Std. Deviation	Median	p value	95 % confidence interval	
								Lower bound	Upper bound
BASELINE	20	4.67	13.10	7.46	2.15	7.49	.604	3.24	11.4
AT 6 WEEKS	20	4.67	10.90	7.38	1.82	7.03	NS*	3.81	10.9
AT 12 WEEKS	20	4.85	11.09	7.50	1.80	7.20		3.97	11.1
AT 18 WEEKS	20	5.03	11.90	7.86	1.79	7.70		4.35	11.3

* NS- Non- significant statistical difference (P>0.05)

The salivary pH at baseline reading, at 6 weeks, at 12 weeks, at 18 weeks was evaluated (Table 3). The minimum value was obtained at base line reading of 6.08 and maximum at 18 weeks interval of 7.80. The salivary pH at all intervals was assessed using ANOVA. The changes in the salivary pH at four intervals were not statistically significant.

The salivary buffering readings at baseline, at 6 weeks interval, at 12 weeks interval and at 18 weeks were assessed (Table 4). The maximum buffering capacity recorded at baseline of 13.10 and minimum at 6 weeks interval. The changes in the salivary buffering capacity at four intervals was not significant using ANOVA.

Salivary flow rate was correlated with salivary pH and salivary buffering capacity at baseline, at 6 weeks, at 12 weeks, at 18 weeks of treatment using Pearson correlation coefficient. The analysis revealed that there was no significant correlation at any of the time intervals.

Discussion

One of the often stated objectives of orthodontic treatment is to promote better dental health and prolong life of the dentition. An ideal occlusion should contribute to the health of the dentition first by creating a normal alignment of the teeth, thus easing the task of maintaining a high level of oral hygiene. Secondly, by creating a functioning occlusion, the destructive changes in the periodontium caused by abnormal functioning occlusion should be avoided and lastly, by minimizing destructive periodontal changes by placing the teeth in good position relative to the alveolar bone. If orthodontic treatment or orthodontic appliance cause significant and permanent periodontal pathology, it would be difficult to ever justify orthodontic treatment.

There have been various studies on the association between orthodontic treatment and changes in salivary function, but the results are not consistent. Chang et al[8] found an increase in stimulated salivary flow rate, pH, buffer capacity after 3 months of active treatment. Liu et al[9] found that during the first month of fixed orthodontic treatment, the whole saliva flow rate and concentration of ions increased significantly but then came back to normal after 3 months.

The purpose of this study was to determine the physiologic changes of salivary flow rate, salivary pH, and buffer capacity as well as changes in periodontal parameters in healthy patients before and during therapy with fixed orthodontic appliances. All patients in the study received oral hygiene instructions and maintained their oral hygiene using fluoride toothpaste, as they had used before orthodontic therapy. None of the patients received

supplementary fluoride, professional cleaning, or other antimicrobial preventive measures.

In the present study changes in salivary function was seen as a physiological response to disturbed intra oral homeostasis. Salivary flow rate as studied in the subject showed an increase from baseline value at 6 weeks, 12 weeks and 18 weeks interval. The increase in salivary flow rate when compared to baseline to 12 weeks and 18 weeks and when compared between 6 weeks and 18 weeks showed highly significant values. This finding in the study is in accordance with the findings of previous studies [8, 10 and 11]. There is strong evidence that salivary flow rate influences both caries risk and caries activity [12]. An increase in salivary flow rate promotes the physical cleansing action of saliva, increases its buffering capacity, anti- bacterial activities and accelerates the clearance of substrates. A low salivary secretion rate not only accentuates the pH drop in plaque fluid following exposure to fermentable substrate but it also delays the pH recovery of plaque fluid. For this reason assessment of salivary flow rate is recognized as important element of diagnosis and management of severe demineralization and acute caries.

In the present study there was increase in salivary pH during the study, with minimum salivary pH at base line of 6.08 and maximum at 18 weeks interval of 7.80. Salivary pH dropped at 12 week interval to 7.11 and again an increase was noticed at 18 week interval to 7.18. But the mean increase of salivary pH was not statistically significant. Increasing salivary flow rate and pH occurred at 12 week or later, highlights that this period of fixed orthodontic therapy is important in possible caries onset complication or in successful host caries defense.

Salivary buffering capacity also increased from baseline level when compared at different time intervals except at 6 week interval where it decreased to 7.38. These increases in salivary buffering capacity were not statistically significant. A mean increase from 7.50 to 7.86 was seen from 12 week interval to 18 week interval; which correlates to the finding of previous studies[8 and 10].

Alessandri Bonetti et al.[13] conducted a study that demonstrated no statistically significant difference between baseline and 1 year for the salivary parameters examined. In the present study salivary flow rate and pH demonstrated an increase in the 1st month of treatment, as opposed to other studies in which it has been established that pH suffers alterations after 3 months of orthodontic treatment8. Orthodontic appliances increase the retentive plaque surfaces, causing elevated acid levels of concentration of hydrogen ions in oral environment, then the pH decrease. However, it was observed that higher flows of stimulated salivary secretion, raises the concentration of bicarbonate ions, then the pH also rises and the buffering power of the saliva increases dramatically; thus demonstrating the physiologic response of saliva to maintain the oral health in adverse situations. Peros et al.[14] found that salivary pH and stimulated flow rate significantly increased after 12 and 18 weeks of fixed orthodontic treatment while buffer capacity remains almost unchanged after 18 weeks if compared to the baseline assessment.

The pH of saliva and its buffering capacity contribute to the ability of saliva to counter the acid produced in the plaque. The chief salivary buffer is the carbonic acid–bicarbonate system, while phosphates and proteins play a minor role. Salivary pH is extremely variable due to the many sources of hydrogen ion complexing. Salivary pH and buffering capacity follow the rate of secretion. In the present study, a correlation was done between salivary flow rate, salivary pH and salivary buffering capacity; it was observed that there was no significant correlation between them at any of the time intervals.

Thus orthodontic treatment changes the oral environmental factors: increases the salivary flow rate, also there is increase in salivary pH over time as well as an increase in salivary buffering capacity, showing increase in the anti caries activity of saliva, but this increase is statistically not significant. There is a need for further studies to compare and evaluate the salivary changes in lingual fixed orthodontic appliances.

Conclusion

Orthodontic treatment changes the oral environmental factors increases the salivary flow rate, also there is increase in salivary pH over time as well as an increase in salivary buffering capacity, showing increase in the anti caries activity of saliva, but this increase is statistically not significant.

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