RESEARCH ARTICLE

Evaluation of the Effect of Fixed and Removable Appliances on Salivary Parameters (Salivary Flow Rate pH and Buffering Capacity) in Children Aged 5–12 Years: An *In Vivo* Study

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Abstract

Aim: To evaluate and compare the effect of fixed and removable space maintainers or appliances on salivary factors ("salivary flow rate," pH, and buffering capacity of saliva) in children aged 5–12 years over a period of 3 months.

Materials and methods: Sixty children were selected for the study and equally alienated into two groups as group I for fixed appliances and group II for removable appliances). Unstimulated saliva was collected from children wearing fixed and removable space maintainers or appliances at baseline, 1, 2, and 3 months.

Results: At the end of 3 months, there was a slight decrease in the buffering capacity and pH of saliva, which was not statistically significant in both the groups. An increase in unstimulated salivary flow rate was also seen in both the groups at the end of 3 months.

Conclusion: Fixed and removable space maintainers or appliances act as opportunistic plaque retentive sites in children, necessitating appropriate oral hygiene maintenance and its reinforcement. Failure to adhere to a strict oral hygiene regimen can cause considerable enamel decalcification and plaque retention leading to alteration in oral microflora which has detrimental effects.

Clinical significance: This study paves way for provision of incorporating practice guideline information for both dentists and children undergoing long-term space maintainer or appliance therapy in children.

Keywords: Decalcification, Fixed appliances, Oral hygiene appraisal, Removable appliances.

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Introduction

Development of primary, mixed, and permanent dentition along with guidance of eruption is a fundamental part of comprehensive oral healthcare for all pediatric dental patients. This guidance should contribute to the development of a stable, functional, and esthetically acceptable permanent dentition. Timely diagnosis and effective management of the developing malocclusion can have long-term benefits along with maintenance of occlusal harmony, function, and dental esthetics.[1]

The rationale behind giving space maintainers or appliances is to guide the erupting permanent teeth, increasing the masticatory efficiency, and enhancement of the esthetics of the individual.[2] The etiology for various malocclusions in the developing dentition is varied and so are the treatment options available for the same. Both fixed and removable orthodontic appliances are used for the correction of developing and already established malocclusions in primary, mixed, and permanent dentitions.[2]

In the past, it has been proved that orthodontic therapy is always associated with increased gingival inflammation due to lack of adequate oral hygiene. This is because fixed and removable orthodontic appliances can interfere with proper oral hygiene appraisal. Insertion of these appliances into the oral cavity can greatly hamper the oral hygiene and increase plaque retention sites which in turn changes the oral environment leading to increase in concentration of bacteria, alterations in buffering capacity of saliva, pH acidity, and salivary flow rate.[3,4]

So, this study was designed to correlate the salivary parameters, that is, flow rate, pH, and buffering capacity of saliva in pediatric patients with intraoral removable and fixed space maintainers or appliances.

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Materials and Methods

The study was conducted in the Department of Pediatric and Preventive Dentistry and the Department of Oral and Maxillofacial Pathology and Microbiology, KLE VK Institute of Dental Sciences, Belagavi. Ethical clearance for the study was obtained from the Institutional Ethical Committee. Sixty

subjects aged between 5 and 12 years belonging to both genders requiring either fixed or removable appliance (space maintainers, habit-breaking appliances) intervention were chosen.

Inclusion Criteria

- Subjects in age-group between 5 and 12 years
- Subjects with a good state of health without any systemic disorders and disability
- Patients with clinically healthy gingiva at the time of delivery of the appliances
- Patients with no previous history of orthodontic treatment.

Exclusion Criteria

- Patients on medications for any chronic illnesses
- Patients on drugs that alter nature and volume of salivary flow within 3 months before entering the study
- Presence of systemic diseases that might affect patient compliance with appliance and oral hygiene appraisal such as mental retardation, physical disability, etc.
- Patients with dentofacial anomalies.

Subjects were divided into two groups as:

- Group I: 30 subjects to undergo treatment with fixed appliances (fixed habit-breaking appliances and space maintainers with banded teeth).
- Group II: 30 subjects undergoing treatment with removable appliances (habit-breaking appliances, removable functional and nonfunctional space maintainers)

A thorough case history, clinical examination, and radiographic investigations (if required) were recorded and the patients were required to complete all their general dentistry procedures. Thorough oral prophylaxis, restorations, pulp therapy, and other required clinical procedures were performed and completed before delivering the appliance. Oral hygiene instructions were given and reinforced at every visit.

Measurement of salivary parameters:

Standardization of the saliva collection technique:

- The subjects were requested not to eat or drink (except water) 1 hour before saliva collection.
- The subject did not perform any physical exercise before saliva collection.
- The saliva was collected between 9.00 and 11.00 am during morning hours.

The children (one at a time) were seated comfortably in the dental chair. Unstimulated whole saliva was collected by spitting method into universal containers and used for assessment of following parameters (Fig. 1).

- **Flow rate analysis:** The volume spitted (spitting method) was analyzed as mL/min by using a graduated syringe to measure the volume of saliva collected in the container.[5]
- **pH analysis**: Salivary pH was assessed using color indicator strips of specific range. One drop of saliva was made to come in contact with the pH strip. Color change was noted and compared with the pH color scale provided with the strip.
- **Buffering capacity analysis**: Ericsson's method was used for assessing the buffering capacity. In this, 0.5 mL of saliva was added to 1.5 mL of 0.0033 mol/L hydrochloric acid in a bottle. pH strip was dipped into this solution and color change was noted and compared with the pH color scale provided with the strip. The pH noted gave the buffering capacity of the saliva.[6]

Appliance fit was checked in the mouth and any adjustments to be made were done. Appliance was then cemented/placed in place and instructions for its use and maintenance of oral hygiene were given.

Statistical Analysis

The mean and standard deviation of parameters, that is, unstimulated salivary flow rate, pH, and buffering capacity of saliva were computed and comparison between the study groups done by using unpaired *t*-test. Within the group, comparison was made by using paired "*t*" test. Test of significance set as $p < 0.05$.

Results

Gender distribution of participants in group I and II showed that 63.3% (38) of the participants were males and 36.7% (22) were females. The gender distribution was found to be similar in both the study groups (Table 1).

Table 2 shows the mean change in unstimulated salivary flow rate at the follow-up times within both the groups. Paired "*t*" test revealed significant increase in group II between 1, 2, and 3 months from baseline.

Table 3 shows the mean change and SD in unstimulated salivary flow rate, pH, and buffering capacity of saliva at various time intervals for both the groups. A decrease of 0.01 ± 0.08 mL/min was seen in group I in the first month followed by an increase in the second and third month. An increase was seen in group II at all follow-up times.

Unpaired "*t*" test reveals statistically significant difference between the study groups with respect to flow rate and buffering capacity of saliva at the end of 1 month and buffering capacity at the end of 2 months.

Figures 2 and 3 show the mean and SD for unstimulated salivary flow rates, pH, and buffering capacity of saliva at different times for groups I and II. Unpaired "*t*" test reveals

Fig. 1: Photograph showing the saliva collection method (spitting method) used in the study

nonsignificant differences between two groups with respect to flow rates and pH, while significant differences were found with respect to buffering capacity of saliva at 1 and 2 months, respectively.

Discussion

The oral cavity is an intricate ecological niche that is reflected by its massive microbial community. For any individual, birth marks the border between the sterile intrauterine life and extrauterine contact with contact with microorganisms that may be acquired by other people, animals, and local milieu. At this time, the oral ecosystem is greatly influenced by physical and chemical fluctuations that occurs secondary to food and drink intake and personal oral hygiene measures.[7] Any disruption in this balance that may be caused by physical factors leading to plaque accumulation or breach in individual's personal oral hygiene measures may lead to deleterious effects.

Table 1: Table showing gender distribution of subjects in group I and group II

Group	*Gender*	*Percentage*
Group I (Fixed appliances)	Male	63.3% (19)
	Female	36.7% (11)
Group II (Removable appliances)	Male	63.3% (19)
	Female	36.7% (11)

In the present study, an attempt was made to quantify and compare the salivary parameters; that is, unstimulated salivary flow rate, pH, and buffering capacity of saliva at the time of placement of the appliance and at 1, 2, and 3 months after the placement of these appliances.

Quantitative and qualitative salivary changes allied with local or systemic disorders are not always easily netted or valued by clinicians and scientists owing to the dearth of calibration in saliva collection techniques. Saliva composition can be termed as "whole" (mixed or total) which is secretions from three pairs of major salivary glands and abundant minor ones (labial, buccal, lingual, and palatal) or "gland specific." Diverse sources (mixed vs individual glands) and techniques (unstimulated vs stimulated) of collection significantly affect the looked-for qualitative or quantitative changes being evaluated.[5,8]

The two superlative techniques to collect whole saliva are the draining method, where saliva is allowed to drip off the lower lip, and the spitting method, in which the subject expectorates saliva into a test tube.[9] In the present study, the spitting method for collection of unstimulated whole saliva was utilized. Although some authors have mentioned that spitting might have some stimulatory effect on salivary flow, the rationale considered for selection of this method over draining method is that less evaporation of saliva is thought to occur when applying the spitting method as compared to draining method, hence providing more reliable data.[8]

In our study, the mean salivary flow rate found at baseline was found to increase in both the groups at the end of 3 months. When both the groups were compared, the increase was found to

Table 2: Table showing '*t*' values and '*p*' values for change in unstimulated salivary flow rates in group I and II at different time intervals

	Group I		
	T1-T2	**T1-T3**	**T1-T4**
***t* value**	0.648	1.690	0.797
***p* value**	**0.522**	**0.102**	**0.432**
	Group II		
***t* value**	2.371	2.644	2.408
***p* value**	**0.006***	**0.013***	**0.023***

*Denotes statistically significant

Table 3: Table showing change in unstimulated salivary flow rate, pH and buffering capacity from baseline to one, two and three months in both groups

	Flow rate		
	T1-T2	*T1-T3*	*T1-T4*
Group I	0.01 ± 0.08	0.03 ± 0.11	0.02 ± 0.13
Group II	0.04 ± 0.08	0.04 ± 0.08	0.03 ± 0.07
***t* value**	2.574	0.745	0.465
***p* value**	**0.013***	**0.807**	**0.644**
	pH		
Group I	0.07 ± 0.28	0.15 ± 0.39	0.3 ± 0.27
Group II	0.7 ± 0.24	0.33 ± 0.23	0.5 ± 0.2
***t* value**	1.927	2.164	1.934
***p* value**	**0.059**	**0.035***	**0.058**
	Buffering capacity		
Group I	0.03 ± 0.22	0.20 ± 0.24	0.4 ± 0.27
Group II	0.28 ± 0.31	0.42 ± 0.37	0.5 ± 0.26
***t* value**	3.553	2.644	1.927
***p* value**	**0.001***	**0.011***	**0.059**

*Denotes statistically significant

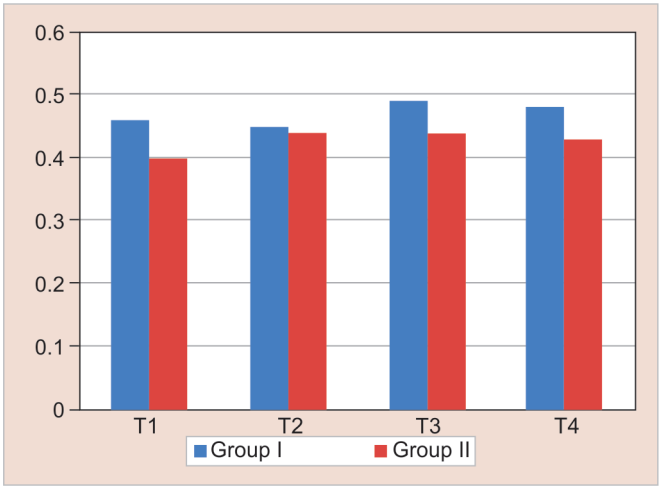

Fig. 2: Graph showing mean unstimulated salivary flow rate (mL/min) in group I and II

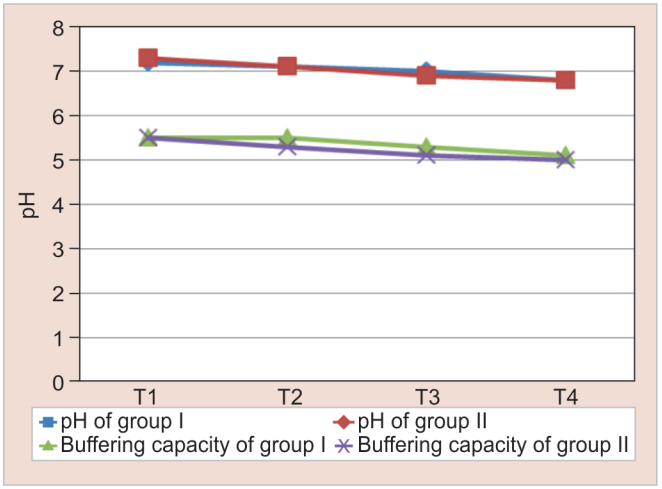

Fig. 3: Graph showing mean pH and buffering capacity of both the groups at various times

be statistically significant in the first month. However, within the group the increase was significant only in patients with removable appliances (group II) at the end of 1, 2, and 3 months (Table 3, Fig. 2).

The unstimulated salivary flow rate varies from 0.22 to 0.82 mL/min in children. The increase in salivary flow rate throughout childhood reflects a developmental process.[10] Our study is in harmony with studies of Chang et al. and Ulukapi et al. which state a prolonged stimulatory effect of treatment with fixed orthodontic appliances on salivary flow.[11,12] Also, the increase in salivary flow rate with the use of orthodontic appliances is beneficial as it offers mechanical cleaning and buffered pH.[13]

In our study, a gradual decrease was seen in intraoral salivary pH and buffering capacity of the patients with both fixed and removable appliances from baseline to a period of 3 months. The decrease in pH was slight after 1 and 2 months following appliance therapy followed by a steep decrease at the end of 3 months in both the groups. When both the groups were compared with regards to pH, the change was significant only after 2 months. Also, there were significant differences in the buffering capacity of saliva between the two groups at the end of 1 and 2 months following placement of appliances (Fig. 3).

In the present study, findings regarding salivary pH and buffering capacity are in accordance with the findings of Arendorf and Addy who reported a significant fall in salivary pH following placement of acrylic removable appliances.[14] Conflicting results were obtained by Ulukapi et al. who reported that buffering capacity of saliva remains unchanged in the patients undergoing orthodontic therapy.[12] Chang et al. found an increase in pH after 3 months and an increase in buffering capacity after 1 month following placement of fixed orthodontic appliances.[11]

These conflicting findings can be attributed to the fact that all these clinical studies have focused on stimulated saliva which has higher concentration of bicarbonate owing to stimulation.[11,12] This in turn causes an increase in pH, and thus giving false values. Also, the data revealing increase in pH and buffering capacity is in relation to only fixed appliances and not removable appliances.[14]

Conclusion

Orthodontic (preventive and interceptive) therapy using fixed or removable space maintainers and appliances is meant to render the dentition a more functional, occlusally harmonious and esthetic form. However, various damaging effects allied with orthodontic therapy put the dentist and the patient in a dilemma toward the delivery of orthodontic therapy.

The current study offers valuable insights into the dynamics of saliva that occur following insertion of fixed and removable appliances. A significant increase in the mean unstimulated salivary flow rate was seen in the patients using removable appliance therapy. A decrease in pH and buffering capacity was seen in both the groups. But when both the groups were compared, significant difference in pH and buffering capacity was seen at the end of 2 and 3 months, respectively.

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