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Evaluation Of Change In Ph Of Saliva Of Orthodontic Patients With Elastomeric Vs Stainless Steel Ligatures: An In-Vivo Study

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Abstract

Aims and Objectives:

- *To evaluate the change in salivary pH of patients undergoing orthodontic treatment with archwire ligation using two techniques of ligation namely stainless steel ligatures and elastomeric modules.*
- *To compare the change in pH of saliva in the same patients due to the effect of stainless steel ligature vs elastomeric modules.*

Materials and Methods: *10 patients (18-30 age group) undergoing fixed orthodontic therapy in the Department of Orthodontics and Dentofacial Orthopaedics, Rajarajeswari Dental College and Hospital, Bangalore.*
All subjects will be treated with straight wire appliances using MBT bracket system. Alignment and leveling are to be initiated with round nickel-titanium archwires and treatment will proceed as required for each patient.
Saliva samples will be collected from the 10 subjects according to the inclusion criteria. Samples will be collected at specific intervals of time for each patient with ligation done using both SS as well as EM ligature.

Results: *Salivary pH level was significantly lesser at T3 time interval as compared to T0, T1 and T2 time intervals and the mean differences were statistically significant.*
However, the mean salivary pH levels did not demonstrate significant differences between T0, T1 and T2 time intervals.

Conclusion: *In short term evaluation, the EM ligation showed significant decrease in salivary pH level as compared to SS ligature wherein the salivary pH was relatively stable.*

INTRODUCTION

Malocclusion is one of the most common dental disorders and is capable of increasing the risk of periodontal disease and dental caries.[1] Orthodontic treatment effectively improves people's quality of life by restoring regular and stable occlusion, optimal chewing function, and dentofacial aesthetics.[2] However, complex design of fixed orthodontic appliances can affect the oral hygiene by influencing several parameters including the saliva properties.[3]

In orthodontic therapy, fixed appliances which are bonded to the teeth create plaque-retentive areas around the bracket wings. This increases chances for plaque accumulation and bacterial colonization.[4] Plaque retention surrounding orthodontic appliances leads to enamel demineralization caused by organic acids produced by bacteria in the dental plaque.

The composition of saliva (including protein content, viscosity, pH, and buffering capacity) and its volume (primarily determined by flow rate) are essential in maintaining the balance between enamel demineralization and remineralization in a cariogenic environment.[5] Specific changes may contribute to decreased susceptibility to dental caries, such as increased pH, buffer capacity and flow rate. [6]

These salivary characteristics gain particular significance during orthodontic treatment with fixed appliances, as the higher risk of plaque accumulation and the challenges in maintaining proper oral hygiene are believed to contribute to enamel demineralization and the formation of white spot lesions.[7]

Salivary pH serves as an indicator of a patient's susceptibility to caries. If salivary pH drops below the critical value (pH = 5.5), the risk of enamel demineralization is increased. This drop contributes to the formation of white spot lesions, reported to occur in around 50% of the orthodontic patients.[8]

The method of ligation can contribute to changes in the salivary pH during fixed orthodontic therapy. This study aims to evaluate the effect of two types of ligature on the salivary pH of orthodontic patients.

Aims and Objectives

The aim of this study is to evaluate the effect of two types of ligatures on the salivary pH in patients undergoing orthodontic therapy

MATERIALS AND METHODS

Source of Data:

10 patients (18-30 age group) undergoing fixed orthodontic therapy in the Department of Orthodontics and Dentofacial Orthopaedics, Rajarajeswari Dental College and Hospital, Bangalore**.**

Inclusion Criteria:

- Age group= 18-30 year old
- Healthy individuals
- Non extraction treatment patients
- Fixed orthodontic appliance therapy
- Non smokers

Exclusion Criteria:

- Any long term oral medication
- Patients with chronic systemic illness
- Recent use of antibiotics
- Periodontally compromised patients

Method of Collection of Data:

- All participants received a standard protocol of oral hygiene instructions and motivation (according to Bass technique) using tooth paste containing fluoride.
- All subjects were treated with straight wire appliances using MBT bracket system. Alignment and leveling was initiated with round nickel-titanium archwires and treatment proceeded as required for each patient.
- Saliva samples were collected from the 10 subjects according to the inclusion criteria. The interval of time between T1 and T2 was taken as a wash over period of 48 hours to prevent clouding of the results of the second intervention.
- Samples were collected at specific intervals of time for each patient with ligation done using both SS as well as EM ligation.
- The same patients' samples were collected to evaluate the difference in pH using the SS and EM ligation for equal periods of time.

Stainless steel (SS) ligature	Elastic module (EM) ligation
T0- before ligation of archwire	T2- 48 hours after removal of SS ligation and before placement of EM ligation
T1- 3 weeks after ligation of archwire with SS ligature	T3- 3 weeks after placement of EM ligation

- Saliva samples were collected in the morning between 9:00 am to 11:00 am in the morning after overnight fasting, using the passive drooling method.
- All participants received a standard protocol of oral hygiene instructions and motivation (according to Bass technique) using tooth paste containing fluoride.
- On the day of sample collection, the subjects were first asked to rinse their mouth thoroughly with plain water and to sit up relaxed for 2 to 3 minutes.
- The subject was seated in the dental chair and instructed to allow saliva to pool in the mouth passively for five minutes, then drool it into a graduated plastic sterile tube.
- The samples were collected at time intervals of T0- before archwire ligation with SS ligatures

T1- 3 weeks after ligation of archwire with SS ligature
T2- 48 hours after removal of SS ligature, before EM ligation
T3- 3 weeks after EM ligation

Figure 1: Pretreatment at T0

Figure 2: SS ligature at T1

Figure 3: EM ligature at T3

- The interval of time between T1 and T2 was taken as a wash over period of 48 hours to prevent clouding of the results of the second intervention

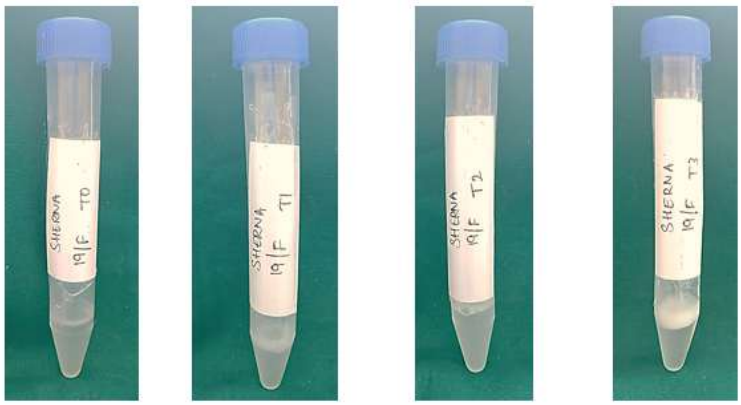

Figure 4: Saliva samples at each time interval

- The subjects received archwire ligation with SS or EM. The ligations were replaced every three weeks during follow-up visits.
- The salivary pH was tested using Konvio Neer pH meter by dipping the meter into the sample and reading the digital result.
- The pH scale covers a range of 14 numbers, where 7 is neutral. Lower numbers are more acidic, while higher numbers are more alkaline.

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Figure 5: Digital pH meter used to measure salivary pH of samples

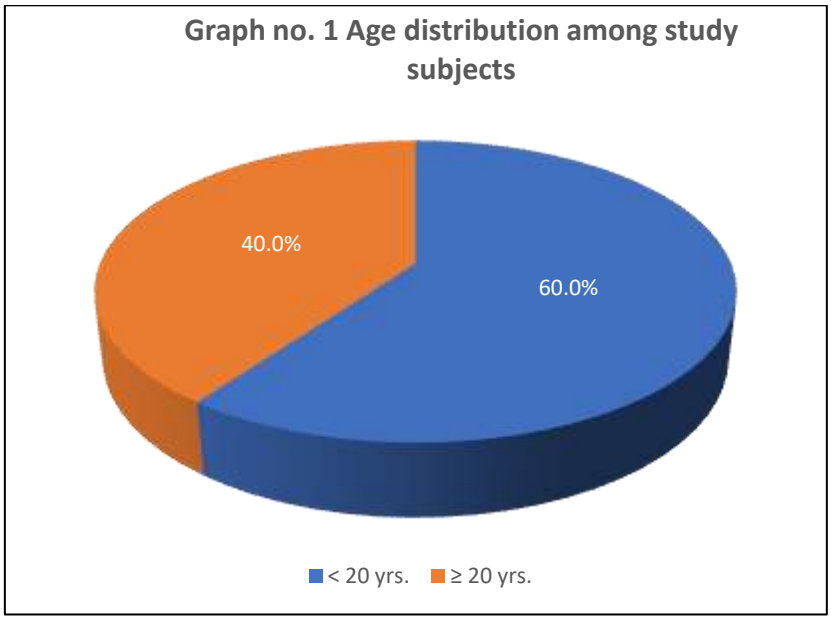
- The procedure was carried out for the 10 patients undergoing treatment with a standard period of 3 weeks using stainless steel ligation followed by 3 weeks using elastomeric ligation.
- A period of 48 hours was given as a wash out period between the two types of ligation where the patient was not given any ligatures so as to avoid clouding of information from one intervention to the other.
- Changes in pH of saliva in these groups were compared and evaluated

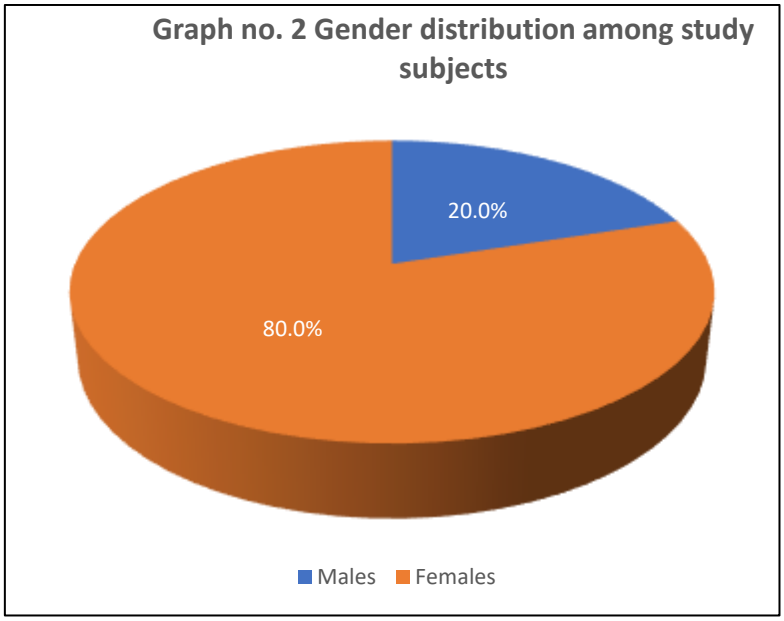
RESULTS

Majority of the study subjects were in the age of < 20 years (60.0%) followed by > 20 years (40%), with mean age of 19.30 ± 2.41 in the range of 16 – 24 years. Males were more predominantly present (80.0%) as compared to their female counterparts (20.0%).

Table 1: Age and Gender distribution among study subjects

Variable	Category	n	%
Age	< 20 yrs.	6	60.0%
	≥ 20 yrs.	4	40.0%
		Mean	SD
	Mean	19.30	2.41
	Range	16 - 24	
Gender	Males	2	20.0%
	Females	8	80.0%





The saliva samples obtained were kept in graduated sterile plastic tubes and the pH was tested using the Konvio Neer pH meter. The pH was measured for the patients at different time intervals. It has been included in Table 2.

Table 2: pH values derived from the salivary samples of patients at 4 time intervals

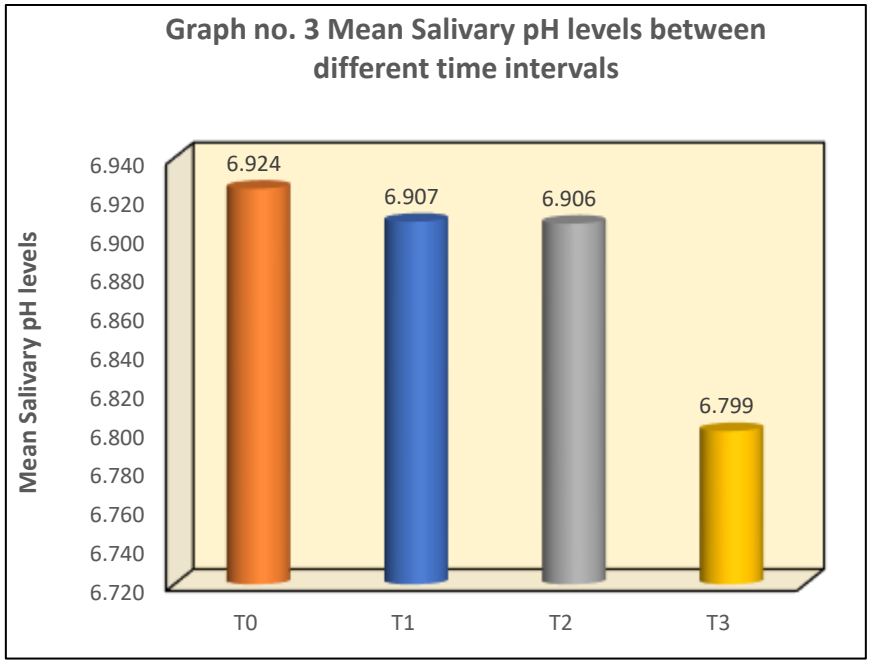
Sl.no	Age/Sex	pH at T0	pH at T1	pH at T2	pH at T3
1	19/M	6.86	6.87	6.87	6.71
2	21/F	6.71	6.73	6.72	6.6
3	20/F	6.73	6.73	6.72	6.7
4	22/F	7.01	6.78	6.78	6.73
5	19/F	6.93	6.86	6.88	6.76
6	20/F	6.89	6.88	6.86	6.63
7	19/F	7.02	7.08	7.12	6.98
8	18/F	7.11	7.09	7.12	7.01
9	24/M	6.73	6.77	6.75	6.71
10	20/F	7.25	7.28	7.24	7.16

Repeated Measures of ANOVA test followed by Bonferroni's post hoc test was used to compare the mean Salivary pH levels between different time intervals among study subjects. The level of significance was set at $p<0.05$.

The mean salivary pH levels at T0 time interval was 6.924 ± 0.178, and at T2 time interval was 6.907 ± 0.184. the mean salivary pH level at T3 time interval was 6.906 ± 0.188 and at T4 time interval was 6.799 ±0.185. These differences in the mean salivary pH levels between different time intervals was statistically significant at $p<0.001$.

TABLE 3: Comparison of mean Salivary pH levels b/w 4 time intervals using Repeated Measures of ANOVA Test

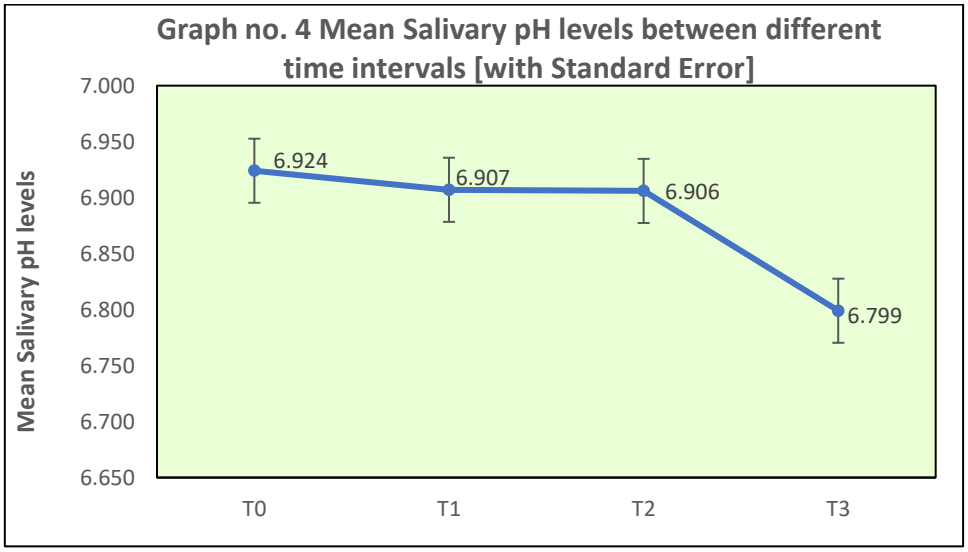
Groups	N	Mean	SD	Min	Max	p-value
T0	10	6.924	0.178	6.71	7.25	<0.001*
T1	10	6.907	0.184	6.73	7.28	
T2	10	6.906	0.188	6.72	7.24	
T3	10	6.799	0.185	6.60	7.16	



Multiple comparison of mean difference between time intervals revealed that the mean salivary pH levels were significantly lesser at T3 time interval as compared to T0, T1 & T2 time intervals and the mean differences were statistically significant at p=0.01, p=0.003 & p=0.003 respectively. However, the mean salivary pH levels did not demonstrate significant differences between T0, T1 and T2 time intervals. This infers that the mean Salivary pH levels showed significant reduction at T3 time interval as compared to T0, T1 & T2 time intervals.

Table 4: Multiple comparison of mean diff. in mean salivary pH levels b/w 4 time intervals using Bonferroni's Post hoc Test

(I) Groups	(J) Groups	Mean Diff. (I-J)	95% CI for the Diff		p-value
			Lower	Upper	
T0	T1	0.017	-0.071	0.105	1.00
	T2	0.018	-0.072	0.108	1.00
	T3	0.125	0.028	0.222	0.01*
T1	T2	0.001	-0.025	0.027	1.00
	T3	0.108	0.041	0.175	0.003*
T2	T3	0.107	0.040	0.174	0.003*



DISCUSSION

Plaque accumulation around fixed orthodontic appliances can compromise enamel integrity and contribute to the development of white spot lesions. Maintaining proper appliance hygiene is therefore essential for enhancing both oral health and treatment outcomes in orthodontic patients.[9]

Fixed orthodontic appliances influence both the quality and quantity of the oral microbiota, leading to a notable rise in acid-producing bacteria, particularly *S. mutans* and *Lactobacilli*, which play a role in lowering salivary pH during treatment.[10,11] This is partly responsible for the decrease in salivary pH in these patients. The current study found the salivary pH to have dropped significantly during the period of utilising EM ligatures compared to the SS ligature. Several earlier studies also examined the effect of fixed orthodontic appliances on salivary pH, comparing values before and after treatment, though without specifying the ligature materials used.[12,13] Additionally, the impact of archwire ligation materials (SS and EM) has been assessed on oral biomarkers other than salivary pH, such as plaque, gingival and bleeding indices, and microbial colonization, often using a split-mouth design.[9,14]

The period of evaluating the change in salivary pH in this study was taken as one month with each method of ligation. This period of time was considered sufficient to demonstrate a determinant change in salivary pH. The other factors such as oral hygiene maintenance and food habits were not considered in the current study due to inability to accurately standardise and regulate them. Unstimulated or resting saliva was chosen for collection, as it remains in prolonged contact with the teeth and is more stable than stimulated saliva.

Al-Haifi et al. in 2021 conducted a study to assess and compare the short-term effects of SS and EM ligatures on salivary pH in orthodontic patients. They reported that EM ligatures led to a significant reduction in salivary pH to unfavourable levels, thereby increasing the risk of enamel demineralization.[7] A consistent decrease in salivary pH was observed in the EM group across all treatment stages.

Since EMs are composed of organic material, they provide a more favourable surface for bacterial colonization compared to SS ligatures, which are inorganic and have an inert metallic surface.[15] Since elastomeric ligatures (EMs) are composed of organic polymers, their porous structure and surface roughness create a microenvironment that facilitates bacterial adhesion and colonization. These ligatures can readily trap food debris and oral biofilm, thereby supporting the growth of acidogenic microorganisms such as *Streptococcus mutans* and *Lactobacilli*.[16] The organic nature of EMs also makes them more susceptible to degradation and discoloration in the oral cavity, further increasing surface irregularities that promote plaque accumulation.[17]

In contrast, stainless steel (SS) ligatures are inorganic and possess a smooth, inert metallic surface that is less conducive to microbial adherence and biofilm maturation. This fundamental difference in material composition and surface characteristics partly explains why EM ligatures are associated with greater reductions in salivary pH, heightened plaque retention, and increased risk of enamel demineralization compared to SS ligatures.[17]

The clinically significant findings from this short-term evaluation indicate that EM ligatures contribute to a reduction in salivary pH, serving as a risk factor for enamel demineralization and the development of white spot lesions during fixed appliance therapy. Monitoring salivary pH may therefore be a valuable component of clinical assessment, particularly in patients with a high caries index.

Some limitations of the current study are the limited sample size and short term evaluation over two months. Blinding of the investigator and participants was not feasible. Type of drinks, food, oral hygiene and other confounding factors are to be considered in future studies.

CONCLUSION

In short-term evaluations, elastomeric ligatures demonstrated a marked reduction in salivary pH, indicating the creation of an unfavourable oral environment that may predispose patients to enamel demineralization and the early development of white spot lesions.

In contrast, stainless steel ligatures maintained relatively stable salivary pH levels throughout the observation period, suggesting that their inert metallic surface is less conducive to bacterial colonization and acid production.

These findings highlight the clinical relevance of ligation material selection in orthodontic therapy, as the choice of EM ligatures may pose an additional risk factor for caries activity and overall enamel integrity during treatment.

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