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RESEARCH ARTICLE

COMPARISON OF FORCE DEGRADATION CHARACTERISTICS BETWEEN LATEX AND NON LATEX ELASTICS AT VARYING pH

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ABSTRACT

Elastics in orthodontics have been used effectively both intra-orally and extra-orally. Their use combined with good patient co-operation provides the clinician with the ability to correct both anteroposterior and vertical discrepancies. It's the intent of the clinician to maintain optimal force values over desired period of time. Force degradation over a period of time is a major problem in the clinical usage of these elastics. Loss of force makes it difficult for the clinician to determine the actual force transmitted to the dentition. Comparative knowledge of this parameter in various latex & non latex elastics could help the clinician in proper selection of elastic for an efficient treatment of the orthodontic discrepancy. This study will be an attempt to compare in vitro performance of the various latex and non-latex elastics by measuring force degradation for the different types of elastics in varying pH.

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INTRODUCTION

Elastics have been used in orthodontics for more than a century (Alavi *et al.,* 2014). They are used to correct anterior-posterior discrepancies because of the forces they produce when stretched. The practitioner relies on the patient to change the elastic in order to maintain the marketed force listed on the package of elastics. Force levels are critically important and orthodontists historically are conscientious in applying only the amount of force needed for healthy tooth movement (Oesterle *et al.,* 2012).

If patient is not compliant or there is substantial force degradation, the treatment objective of correcting the anterior-posterior discrepancies cannot be achieved. The elastics lose their force over time due to their properties and the environment within the mouth. Brawley found that the pH of saliva in 3405 cases ranged from 5.6 to 7.6, with a mean of 6.75. Even when relatively strong solutions of acid and alkali are ingested, the salivary pH quickly reverts to the individual subject's baseline pH (Ferriter *et al*). Studies showed that polyurethane elastics in a basic pH degraded more than if the pH was acidic (Ferriter, Meyers and Lorton 1990).

With In-vivo testing, it is difficult to compare manufacturers or evaluate the load that is placed on the elastics based on the highly variable intraoral environment and the inability to rule out other variables, such as pH, in each individual. This study was done to evaluate and compare force degradation over a desired period of time in varying pH.

METHODOLOGY

Source of Data: This experimental study was performed on samples of two different types of elastics of 3.2 mm internal diameter (1/8 inches) with different force values obtained from two different manufacturers.

Two types of elastics used were

- Latex
- Non latex

Each type was further categorized according to their manufacturers

- American Orthodontics (AO)
- Forestadent

Equipments Used

- Water heating bath
- Artificial saliva
- Digital force gauge (EFG 10 E)
- Separating plier
- pH meter

Comparing elastics at different pH: Load relaxation between latex and non latex elastics in varying salivary pH was compared. Two glass bowls which contain artificial saliva at two different pH were used. Two acrylic blocks were dipped in two seperate glass bowls and stored in water heating bath at 37^0 C. Only load relaxation was compared. The test was done over a period of 12 hours instead of 48 hours and at intervals of 1 hour, 4 hour, 8 hour, 12 hours. Various elastics were divided into four groups. Sample of 10 elastics were taken from each group.

Group.1. AO: Latex elastic; Medium force as shown in (Fig: 4.1 a).

Group.2. AO: Non-latex elastic; Medium force as shown in (Fig: 4.1 c).

Group.3. Forestadent: Latex elastic; Medium force as shown in (Fig: 4.2 a).

Group.4. Forestadent: Non-latex elastic; Medium force as shown in (Fig: 4.2 c)

Data Collection: The force in gram-force (gf) was used to calculate the percent of initial force loss of AO and forestadent 1/8", medium force latex and non-latex elastics as they degraded in varying normal resting salivary pH levels in a static environment.

The data was reported in percent of initial force. The elastics were placed in artificial saliva adjusted to these two pH levels 5.60 (acidic), 6.75 (resting salivary pH) at a temperature of 37°C for a period of 12 hours.

A sample size of 10 elastics were used in this study.

Load relaxation test: 48 hours load relaxation mechanical testing at 1 hour, 4 hour, 8 hour, 12 hour were conducted with a force gauge. The elastics were mounted between two stainless steel pins on acrylic board. The pins were set apart at a fixed distance so as to stretch the elastics to three times (9.6mm) the marketed internal diameter. The acrylic board was dipped in artificial saliva and the temperature of the artificial saliva was regulated at 37°C using water heating bath to simulate the oral environment. The ingredients of the artificial saliva were as follows: 1.3 g/l potassium chloride, 0.1 g/l sodium chloride, 0.05 g/l magnesium chloride, 0.1 g/l calcium chloride, 2.5×10^{-5} g/l sodium fluoride, 0.035 g/l potassium dihydrogen phosphite and 0.162 g/l zinc sulphate. The pH value was set at 6.75. Appropriate pH was adjusted by adding 2M HCl or 2M NaOH. Preliminary runs of this experiment, where the elastics were allowed to relax during their transfer to and from the force gauge, had highly variable results.

For this study, the elastics were placed using separating pliers that were adjusted to create a jig to transfer the elastics at exactly 9.6 mm to and from the acrylic blocks and the force gauge. This avoided any relaxation and maintained the same distance during the entire experiment by simply squeezing the separating pliers to maximal opening for the desired stretched distance of 9.6 mm as pictured in. They were then immediately placed on the EFG 10 E Force Gauge for the initial reading and than transferred back to the appropriate number on the acrylic blocks submerged in the artificial saliva. Elastics were gauged at mentioned time intervals. The diameter of both hooks on the force gauge was 1.0 mm, which matched the pins on the acrylic blocks. From each specimen, the percentage of force degradation (%R) will be obtained as follows: $\%R = 100 \times (F_o - F_t)/F_o$ Where F_0: Initial force; F_t: Force at that particular time 1, 4, 8, 12 hrs. Percentage of load remaining (%LR) will be obtained as follows:

$$\%LR = 100 - \%R$$

Where %R: Percentage of force relaxation (1, 4, 8, 12 hrs). Forces were measured at 1 hour, 4 hour, 8 hour, 12 hour interval. pH was monitored by pH meter regularly and adjusted accordingly by addition of 2M of HCl or NaOH to the solution. The data was collected in percent of initial force so that the force loss would be comparable despite the varying initial

Statistical analysis: The comparison amongst different groups were made using ANOVA test and Tukey's HSD test and Level of significance i.e P value < 0.05 was considered.

RESULTS AND DISCUSSION

Several properties of latex and non-latex elastics have been evaluated, some involving saliva or simulated saliva solutions. Few studies have investigated the effects of salivary pH levels on visco-elastic force relaxation of non-latex inter-arch elastics. Great individual pH variability is noted within the oral cavity, and this can fluctuate with diet.

Comparison of mean (Tukey's HSD Test) of percentage load left with AO latex medium group at 1, 4, 8, 12 hour interval at 5.6 and 6.75 pH

ELASTIC TYPE		LOAD I HOUR		LOAD 4 HOUR		LOAD 8 HOUR		LOAD 12 HOUR	
		Ph 5.6	pH 6.75	pH 5.6	pH 6.75	pH 5.6	pH 6.75	pH 5.6	pH 6.75
AO MEDIUM LATEX	MEAN	78.96	78.282	77.31	75.31	75.9	72.1	73.9	71.969
	SD	1.4393	1.1802	1.1487	1.4146	1.0604	2.1302	1.7901	1.6948
	Q VALUE	1.4256		4.1729		8.1006		0.2826	
	P VALUE	0.9000		0.0777		0.0010		0.8990	
	STATUS	Non-significant		Non-significant		Significant		Non-significant	

Comparison of mean (Tukey's HSD Test) of percentage load left with AO Non-latex medium group at 1, 4, 8, 12 hour interval at 5.6 and 6.75 Ph

ELASTIC TYPE		LOAD I HOUR		LOAD 4 HOUR		LOAD 8 HOUR		LOAD 12 HOUR	
		pH5.6	pH 6.75	pH 5.6	pH 6.75	pH 5.6	pH 6.75	pH 5.6	pH 6.75
AONON-LATEXDIUM	MEAN	77.01	77	75.9	73.1	72.2	70.9	72.1	70
	SD	1.0385	0.7777	1.7701	1.1032	1.6765	2.5427	1.3912	1.8117
	Q VALUE	1.3089		5.5138		2.592		1.7905	
	P VALUE	0.8999947		0.0050337		0.5871161		0.8999947	
	STATUS	Non-significant		Significant		Non-significant		Non-significant	

The pH of the oral environment that affects orthodontic chain elastics is influenced by the pH of both saliva and dental plaque. (Brawley found the pH of saliva in 3405 cases ranged from 5.6 to 7.6, with a mean of 6.75.) Even when relatively strong solutions of acid and alkali are ingested, the salivary pH quickly reverts to the individual subject's baseline pH (Ferriter, Meyers & Lorton 1990, p. 404). The purpose of our study was to compare latex and non-latex elastics with varying pH. Two pH selected were 5.6 (acidic) and 6.75 (resting salivary pH). The comparison was done in medium force group between two different manufacturers and two different types (latex and non-latex).The time points chosen were 1, 4, 8, 12 hours because most of the force relaxation occurred during initial hours.

In acidic pH 5.6: When AO latex elastics were compared to AO non-latex there was significant difference, non-latex showed significantly greater force degradation than latex elastics. At 4, 8 and 12 hour there was consistently greater force degradation with non-latex elastics. When forestadent latex elastics were compared to forestadent non-latex there was consistently greater force degradation with non-latex elastics. Most of the force degradation occurred before 1 hour (13%-17%) in all the elastics, thereafter there was force degradation of only (4%-6%) from 1 hour to 12 hours.

In resting salivary pH 6.75: When AO latex elastics were compared to AO non-latex there was significant difference. Non-latex showed significantly greater force degradation than latex elastics at timepoints 4 and 12 hours.Most of the force degradation occurred before 1 hour (22%-23%) in all the elastics, thereafter there is force degradation of only (6%-7%) from 1 hour to 12 hours. When forestadent latex was compared to forestadent non-latex there was significant difference at two timepoints, non-latex showed significantly greater force degradation than latex elastics. At 1and 12 hour there was significant greater force degradation with non-latex elastics. Most of the force degradation occurred before 1 hour (13%-19%) in all the elastics, thereafter there is force degradation of only (7%-8%) from 1 hour to 12 hours. Above mentioned comparison showed that there was consistently more force degradation with non-latex elastics at both pH values.

These results were in accordance with the results given by Kamisetty et al. (2014): Sauget, Stewart & Katona (2011). Comparing all groups at two different pH at 1 hour showed difference in AO group was insignificant but there was significant difference among forestadent group. Forestadent latex elastics showed lower force degradation at pH 5.6 compared to pH 6.75. Similar result was found with forestadent non-latex group. Comparing all groups at two different pH at 4 hours showed significant difference with all the groups except AO medium latex. Force degradation was lower in pH 5.6 than 6.75 consistently among all groups. Comparing all groups at two different pH at 6 hours showed significant difference with all the groups except AO medium non-latex. Force degradation was lower in pH 5.6 than 6.75 consistently among all groups. Comparing all groups at two different pH at 12 hours showed non-significant difference with all the groups. Consistent finding amongst above comparisons revealed lower force degradation in acidic pH than resting salivary pH. These results were similar to study conducted by Ferriter et al., (1990) which concluded that clinically, it would seem that an oral pH lower than 7.26 would retard the force-decay rate of the chain elastics.

Conclusion

Non-latex elastics showed greater force degradation as compared to latex elastics. Over a period of 48 hours, there was a decrease in the loads generated by all elastics. The amount of force that was retained at the end of one day and two days was not significantly different for both latex and non-latex elastics. However, the latex elastics retained larger loads than the non latex elastics and fore stadent elastics retained larger load than AO in most of the comparisons. Force degradation was higher in the heavy elastics when compared with the medium. Elastics had lesser force degradation at acidic pH (5.6) as compared to pH 6.75

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