Original Article

Do mouthwashes with and without bleaching agents degrade the force of elastomeric chains?

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ABSTRACT

Objective: To evaluate, in vitro, the effect of mouthwashes with and without bleaching agents on the force of elastomeric chains.

Materials and Methods: A total of 108 elastomeric chain specimens was divided into six groups (n = 18 in each group). Two test groups were exposed to two types of commonly used mouthwashes (Plax and Listerine), and two groups were exposed to mouthwashes containing bleaching agent (Plax Whitening and Listerine Whitening). Immersion in the solutions was performed twice a day for 60 seconds. One group of control specimens remained immersed in artificial saliva throughout the entire experimental period, and the other control specimens were exposed to distilled water. Force measurements were performed at six time intervals (initial, 1 day, 7 days, 14 days, 21 days, and 28 days).

Results: No statistically significant differences were found between the groups in the initial period ($P > .05$). Statistically significant differences were found between the control group and the Plax, Plax Whitening, and Listerine groups at the time intervals of 7, 14, and 21 days. In the initial period, the force was statistically significantly higher than it was in any of the other experimental periods ($P < .05$). The control group with distilled water and the test group with Plax Whitening maintained the most force during the experimental period.

Conclusion: The presence of bleaching agent has no influence on the force degradation of elastomeric chains. (*Angle Orthod.* 2013;83:712–717.)

KEY WORDS: Force degradation; Elastomeric chain; Mouthwash

INTRODUCTION

The elastomeric chain is commonly used in orthodontics; therefore, viscoelastic power and loss of force over time must be strictly tested.[1–3] A rapid loss of force in a viscoelastic chain causes inefficient tooth movement, which will result in a need for an increased number of consultations to reactivate the appliance.[4]

The use of mouthwashes during orthodontic treatment is recommended by dentists for the maintenance of oral hygiene and a reduction in the frequency of caries lesions.[5] However, many adverse effects of different commercially available mouthwashes on the oral cavity have been described in the literature. The most common are mucosa desquamation, ulceration, inflammation, and petechiae, in addition to allergic reactions, burning mouth sensation, and hyperkeratinization of the oral mucosa; weakening of the teeth may also occur.[6]

In addition to oral hygiene maintenance, the intensity of the quest for esthetics has also increased in dentistry. Increasing numbers of individuals seek the perfect smile, and for this reason, various dental bleaching techniques have been used extensively. The use of products that have this effect is most worthwhile in products such as mouthwashes with whitening action, which include low percentages of peroxide.[7]

Several studies that have investigated the force degradation of different orthodontic elastics as the result of different pH,[8,9] artificial saliva formulations,[10] temperatures,[11] and alcohol concentrations in mouth-

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Table 1. List of Experimental Groups and Their Components

Group		Components	Composition
Control	1	Distilled water	
	2	Artificial saliva	Potassium chloride, sodium chloride, magnesium chloride, potassium phosphate, calcium chloride, Nipagin, Nipazol, carboxymethyl cellulose, sorbitol, purified water.
Test	3	Colgate Plax	Water, glycerine, propylenoglycol, sorbitol, poloxamer 407, flavoring, cetylpyridine bromide (?) cloruro de cetilpiridinio , sodium fluoride (?) fluoruro de sódio, methylparaben, sodium saccharine, propylparaben. Active ingredients: 0.05% sodium fluoride (?) fluoruro de sódio, 0.075% cetylpyridine bromide (?) cloruro de cetilpiridinio.
	4	Colgate Plax Whitening	Water, sorbitol, ethyl alcohol, hydrogen peroxide (1.5%), poloxamer 338, polysorbate 20, methyl salicylate, menthol, sodium saccharine, CI 42090.
	5	Listerine	Water, sorbitol solution, 21.6% alcohol, poloxamer 407, benzoic acid, mint essence, sodium saccharine, sodium benzoate, yellow coloring #10, green coloring #3.
	6	Listerine Whitening	Water, alcohol (8%), hydrogen peroxide, sodium phosphate, poloxamer 407, lauryl sodium sulfate, sodium citrate, mint aroma, menthol, eucalyptol, sodium saccharine, sucralose.

washes.[3] Nevertheless, there is still no information about the effect of mouthwash solutions containing bleaching agents on the force degradation of elastomeric chains. Therefore, the aim of this study was to evaluate the effect of mouthwashes with and without bleaching agents on the force degradation of elastomeric chains in vitro to determine whether the presence of one or more bleaching agents would increase the force degradation.

MATERIALS AND METHODS

A prospective laboratory study was conducted to test the effect of the exposure of orthodontic elastomeric chains to mouthwashes with or without bleaching agents. Six groups of samples were tested; each group included 18 elastics (total n = 108). The elastics used were of the short spacing type (Morelli, Sorocaba, Brazil). Because these elastomeric chains are fabricated in a single continuous chain, they were cut to a standard length, so that, for each sample, five links were left free and two links were used for fixation onto the jigs.

The specimens were mounted on personalized test jigs. To fabricate the personalized jigs, polyvinyl chloride (PVC) tubes were used, in which small holes were made to insert the supporting rods for the orthodontic chain elastics. Self-polymerizing acrylic resin was injected into the PVC tube to fix the rods. The holes were separated by a mean horizontal distance of 0.5 cm. On the test setup, the elastic was put into place and stretched along a vertical distance of 23.5 mm (this measure was constant during the measurement). These jigs allowed the elastomeric chains to be completely submerged in an artificial saliva solution throughout the experimental period and allowed immersion in the test solutions as well. The test groups were exposed to the analyzed solutions twice a day, for 60 seconds each, with an interval of 12 hours between one daily exposure and the other. The test period was completed after 28 days. Force measurements were performed at six different time intervals (initial and 1, 7, 14, 21, and 28 days). This study followed the norms for testing of elastomeric orthodontic auxiliaries (International Organization for Standardization 21606-2007).

The samples evaluated were: distilled water (control group, group 1); artificial saliva (control group, group 2); Colgate Plax (Colgate-Palmolive Ind. e Com. LTDA, São Paulo, SP, Brazil; manufacturing lot 11BR123B) (group 3); Colgate Plax Whitening (Colgate-Palmolive Ind. e Com. LTDA; manufacturing lot BR122A) (group 4); Listerine Mouthrinse (Johnson & Johnson, São José dos Campos, SP, Brazil; manufacturing lot 0691B06) (group 5); and Listerine Whitening (Johnson & Johnson; manufacturing lot 0671C) (group 6). These mouthwashes were chosen for the study because they are widely used by the population and are internationally recognized (Table 1). In another six receptacles, one for each

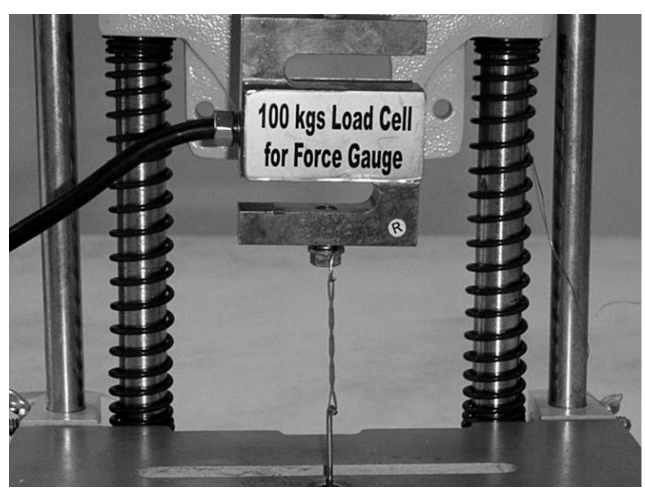

Figure 1. Digital dynamometer (Instrutherm DD-300) used to measure the force exerted by elastomeric chains.

Table 2. Mean Force Values (kg), Standard Deviations (SDs), and Statistical Analysis (Comparison Between Groups by Time) of the Groups Evaluated

	Initial		24 h		7 d	
Group[a]	Mean (SD)	*P* values[b]	Mean (SD)	*P* values[b]	Mean (SD)	*P* values[b]
1	5.61 (0.75)	G2 $P = .972$	4.72 (0.57)	G2 $P = .000$*	4.56 (0.59)	G2 $P = .000$*
		G3 $P = .641$		G3 $P = .861$		G3 $P = .173$
		G4 $P = .912$		G4 $P = .541$		G4 $P = .888$
		G5 $P = .824$		G5 $P = .506$		G5 $P = .621$
		G6 $P = .574$		G6 $P = .166$		G6 $P = .380$
2	5.85 (0.92)	G3 $P = .972$	3.75 (0.40)	G3 $P = .006$*	3.32 (0.41)	G3 $P = .005$*
		G4 $P = 1.000$		G4 $P = .033$*		G4 $P = .000$*
		G5 $P = .354$		G5 $P = .039$*		G5 $P = .000$*
		G6 $P = .952$		G6 $P = .186$		G6 $P = .001$*
3	6.1 (1.04)	G4 $P = .995$	4.48 (0.55)	G4 $P = .994$	4.07 (0.62)	G4 $P = .785$
		G5 $P = .072$		G5 $P = .991$		G5 $P = .965$
		G6 $P = 1.000$		G6 $P = .809$		G6 $P = .998$
4	5.93 (0.95)	G5 $P = .230$	4.37 (0.73)	G5 $P = 1.000$	4.34 (0.67)	G5 $P = .997$
		G6 $P = .989$		G6 $P = .980$		G6 $P = .954$
5	5.22 (0.50)	G6 $P = .055$	4.36 (0.62)	G6 $P = .986$	4.24 (0.73)	G6 $P = .999$
6	6.13 (1.33)		4.23 (0.71)		4.16 (0.60)	

* Statistically significant differences ($P < .05$).

[a] 1 indicates control (distilled water); 2, control (artificial saliva); 3, Plax; 4, Plax Whitening; 5, Listerine; and 6, Listerine Whitening.

[b] Comparisons between group (G) numbers are shown.

group, artificial saliva was reserved for immersion of the samples.

The test groups were independently submerged in a solution with artificial saliva at 37°C, kept in an oven (Splabor, São Paulo, Brazil), and monitored daily with a digital thermometer and thermostat (Splabor, São Paulo, Brazil). One control group remained immersed in artificial saliva and the other remained in distilled water throughout the entire test period; both were also kept in the oven at 37°C.

After submersion in the respective mouthwash solutions, the specimens were washed with distilled water, simulating the rinsing that occurs in the oral cavity after the use of a mouthwash, to eliminate any residual mouthwash. After this, the specimens were returned to the artificial saliva bath at 37°C.

Six force measurements were performed at the following time intervals: initial (0 days) and 1, 7, 14, 21, and 28 days. These measurements were obtained with a dynamometer (Instrutherm DD-300, São Paulo, Brazil) (Figure 1). After each measurement, the dynamometer was set to a zero readout before proceeding with the next measurement. Measurements were made by removing the elastics from the jigs and fixing them onto the pins of the measuring instrument; this allowed the tensile force to be measured.

The measurement readouts were made with the elastomeric chains elongated to 23.5 mm, maintaining

Table 3. Comparison of Force Values (kgf) Within Each Group at Different Evaluation Times

	Group 1[a]	*P* values	Group 2[a]	*P* values	Group 3[a]	*P* values
Initial	5.61 (0.75)	24 h $P = .002$*	5.85 (0.92)	24 h $P = .000$*	6.1 (1.04)	24 h $P = .000$*
		7 d $P = .000$*		7 d $P = .000$*		7 d $P = .000$*
		14 d $P = .000$*		14 d $P = .000$*		14 d $P = .000$*
		21 d $P = .000$*		21 d $P = .000$*		21 d $P = .000$*
		28 d $P = .000$*		28 d $P = .000$*		28 d $P = .000$*
24 h	4.72 (0.57)	7 d $P = .982$	3.75 (0.40)	7 d $P = .110$	4.48 (0.55)	7 d $P = .547$
		14 d $P = .298$		14 d $P = .004$*		14 d $P = .403$
		21 d $P = .249$		21 d $P = .003$*		21 d $P = .277$
		28 d $P = .151$		28 d $P = .002$*		28 d $P = .121$
7 d	4.56 (0.59)	14 d $P = .729$	3.32 (0.41)	14 d $P = .839$	4.07 (0.62)	14 d $P = 1.000$
		21 d $P = .667$		21 d $P = .806$		21 d $P = .998$
		28 d $P = .505$		28 d $P = .770$		28 d $P = .954$
14 d	4.25 (0.66)	21 d $P = 1.000$	3.12 (0.28)	21 d $P = 1.000$	4.02 (0.67)	21 d $P = 1.000$
		28 d $P = .999$		28 d $P = 1.000$		28 d $P = .988$
21 d	4.23 (0.39)	28 d $P = 1.000$	3.11 (0.29)	28 d $P = 1.000$	3.96 (0.74)	28 d $P = .998$
28 d	4.17 (0.91)		3.1 (0.39)		3.86 (0.64)	

* Statistically significant differences ($P < .05$).

[a] Groups: 1 indicates control (distilled water); 2, control (artificial saliva); 3, Plax; 4, Plax Whitening; 5, Listerine; and 6, Listerine Whitening.

Table 2. Extended

14 d		21 d		28 d	
Mean (SD)	P values[b]	Mean (SD)	P values[b]	Mean (SD)	P values[b]
4.25 (0.66)	G2 $P = .000$*	4.23 (0.39)	G2 $P = .000$*	4.17 (0.91)	G2 $P = .000$*
	G3 $P = .837$		G3 $P = .571$		G3 $P = .697$
	G4 $P = .863$		G4 $P = .076$		G4 $P = .029$*
	G5 $P = .639$		G5 $P = .025$*		G5 $P = .259$
	G6 $P = .454$		G6 $P = .054$		G6 $P = .311$
3.12 (0.28)	G3 $P = .000$*	3.11 (0.29)	G3 $P = .000$*	3.1 (0.39)	G3 $P = .007$*
	G4 $P = .000$*		G4 $P = .001$*		G4 $P = .399$
	G5 $P = .001$*		G5 $P = .004$*		G5 $P = .058$
	G6 $P = .002$*		G6 $P = .001$*		G6 $P = .044$*
4.02 (0.67)	G4 $P = 1.000$	3.96 (0.74)	G4 $P = .882$	3.86 (0.64)	G4 $P = .563$
	G5 $P = .999$		G5 $P = .660$		G5 $P = .978$
	G6 $P = .989$		G6 $P = .818$		G6 $P = .989$
4.03 (0.61)	G5 $P = .999$	3.78 (0.46)	G5 $P = .998$	3.51 (0.74)	G5 $P = .937$
	G6 $P = .983$		G6 $P = 1.000$		G6 $P = .905$
3.95 (0.52)	G6 $P = 1.000$	3.72 (0.42)	G6 $P = 1.000$	3.71 (0.56)	G6 $P = 1.000$
3.9 (0.65)		3.76 (0.47)		3.73 (0.45)	

the same length as that of the jig pins. All chains were manipulated by the same operator to ensure standardized measurements.

Statistical Analysis

Statistical analyses were performed with the program SPSS 13.0 (SPSS Inc, Chicago, Ill). Descriptive statistical analyses, including means and standard deviations, were performed for the groups evaluated. The values for the amount of force released were submitted to analysis of variance to determine whether there were statistical differences among the groups, and the Tukey test was performed subsequently. Differences were considered statistically significant when $P < .05$.

RESULTS

With respect to the groups at the same time interval, no statistically significant differences were found between the groups in the initial period ($P > .05$). Statistically significant differences were found between group 1 and groups 3, 4, and 5 at the time intervals of 7, 14, and 21 days (Table 2).

When the groups were evaluated individually over time, in the initial period, the force was statistically significantly higher than in all other experimental

Table 3. Extended

Group 4[a]	P values	Group 5[a]	P values	Group 6[a]	P values
5.93 (0.95)	24 h $P = .000$*	5.22 (0.50)	24 h $P = .000$*	6.13 (1.33)	24 h $P = .000$*
	7 d $P = .000$*		7 d $P = .000$*		7 d $P = .000$*
	14 d $P = .000$*		14 d $P = .000$*		14 d $P = .000$*
	21 d $P = .000$*		21 d $P = .000$*		21 d $P = .000$*
	28 d $P = .000$*		28 d $P = .000$*		28 d $P = .000$*
4.37 (0.73)	7 d $P = 1.000$	4.36 (0.62)	7 d $P = .988$	4.23 (0.71)	7 d $P = 1.000$
	14 d $P = .696$		14 d $P = .268$		14 d $P = .779$
	21 d $P = .140$		21 d $P = .013$*		21 d $P = .450$
	28 d $P = .005$*		28 d $P = .011$*		28 d $P = .370$
4.34 (0.67)	14 d $P = .779$	4.24 (0.73)	14 d $P = .665$	4.16 (0.60)	14 d $P = .901$
	21 d $P = .188$		21 d $P = .077$		21 d $P = .618$
	28 d $P = .009$*		28 d $P = .066$		28 d $P = .534$
4.03 (0.61)	21 d $P = .907$	3.95 (0.52)	21 d $P = .825$	3.9 (0.65)	21 d $P = .995$
	28 d $P = .247$		28 d $P = .794$		28 d $P = .986$
3.78 (0.46)	28 d $P = .850$	3.72 (0.42)	28 d $P = 1.000$	3.76 (0.47)	28 d $P = 1.000$
3.51 (0.74)		3.71 (0.56)		3.73 (0.45)	

periods ($P < .05$). Groups 1 and 4 maintained the most force throughout the experiment (Table 3).

DISCUSSION

Orthodontic elastics are important sources of force transmission to the teeth and are therefore widely used in orthodontics. Nevertheless, these materials are not considered ideal, as the force they generate diminishes gradually during the activation period.[12,13] Therefore, various studies[3,8–11] have sought to establish the mechanical and environmental factors that contribute to the force degradation of different orthodontic elastics. Mouthwashes are commonly used by orthodontic patients; thus, it is vital to investigate how mouthwashes affect orthodontic devices.

This experiment tested mouthwashes containing hydrogen peroxide, which has a tooth-whitening action. The fact that there is a quest for esthetics in contemporary society, and consequently for tooth whitening, has resulted in the addition of peroxide to mouthwashes. Hydrogen peroxide reacts with organic molecules, rupturing their ionic bonds and altering their absorption of energy, resulting in changes in the optical structure of teeth.[14]

The action of mouthwashes occurs by contact/friction of the substance with the oral cavity (teeth, mucosa, and tongue), and for this reason persons who use them agitate the mouthwash in the mouth. In the present experiment, contact with the mouthwashes was only by immersion of the elastics in the liquids, without agitation, although generally some substances need to be agitated to react. Future studies should determine the relationship of the friction of bleaching substances with the force degradation of elastomeric chains.

The results of this experiment showed that the interaction of the elastics with mouthwashes with a bleaching effect had no significant influence on the loss of force. Similar results were found when the effects of pigment and manufacturing were evaluated[15] and when elastic chains were immersed in Light Coke.[13]

A controversial result was reported by Nattrass et al.[16] Their study evaluated the influence of three common environmental factors on the force degradation of elastomeric chains in an aqueous medium (Coca-Cola, a medium rich in additives), with temperatures controlled at 10°C, 22°C, and 37°C. All media influenced the elastomeric chains, although the high temperature may have influenced the results. In the present study, a constant temperature of 37°C was used, which corresponds to the body temperature.

Kersey et al.[17] evaluated the characteristics of force decline of interarch elastics, with and without latex, within a normal range of salivary pH levels and observed no significant correlation between pH and reduction in force. Dittmer et al.[12] investigated the influence of artificial aging on the mechanical properties of orthodontic elastomeric chains (power chains) without an intermodular link. They found that initial force levels exceeded the desired orthodontic forces. However, a significant drop in force occurred within a relatively short time. Similar results were observed in the present study.

Teixeira et al.[13] observed that the greatest relaxation of the elastomeric chain occurred within 24 hours after its extension. The present study observed a similar phenomenon, in which the greatest force degradation occurred during the first 24 hours. The elastomeric chains were evaluated over a period of 28 days, as indicated by various studies,[1,3,10,18] because this period coincides with the mean frequency of changing synthetic elastics practiced by orthodontists. No statistically significant differences were found among the groups in the initial period ($P > .05$). The force was measured initially and after time intervals of 1, 7, 14, 21, and 28 days using a digital device. At the time of measurement, all the samples were transferred from the test solutions to the dynamometer; thus, the specimens were kept stretched continuously during the test period, avoiding the elastic recovery phenomenon, and consequently providing false results.

The samples were heterogeneous with regard to the force initially generated, although all the groups showed the greatest decrease in force during the first 24 hours of activation. To determine whether there was any influence of substances other than saliva on the force degradation of these elastics, all the samples were kept stretched to 23.5 mm and immersed in artificial saliva at 37°C to simulate body temperature, since it is known that this does have a significant influence on the loss of force experienced by synthetic elastics.[11]

In this study, during a 28-day period, the greatest loss of force occurred in the artificial saliva control group, demonstrating that there is no relationship between the loss of force and contact with substances present in mouthwashes, irrespective of whether they include a whitening agent. One limitation of the study was the fact that the elastic was removed from the jig five different times, which does not occur clinically, and this may have influenced the results. However, the influence of this is minimized by the fact that all groups received the same treatment.

CONCLUSIONS

- The samples were shown to be heterogeneous with regard to the force initially generated and with regard to degradation in force during the first 24 hours of activation.

- The presence of a bleaching agent had no significant influence on force degradation of the elastomeric chains.

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