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Research Article

Experimental Evaluation of Strength Degradation of Orthodontic Chain Elastics Immersed in Cola Beverage

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Abstract

Objective: Elastics are relevant in Orthodontic mechanics due to the form memory property; however, elastomers present high reduction of strength in some circumstances. The objective was to evaluate the effect of cola soft drink in tensile strength degradation of orthodontic chain elastics.

Method: Three groups were tested according to different immersion liquids: artificial saliva (control group, 1), cold water (group 2) and cola drink (Coca Cola® group 3). The elastics of groups 2 and 3 were immersed in the respective liquids, with temperature of 5°C ± 1, two times per day for 30 seconds, for the period of 7, 14 or 21 days. All samples were kept in artificial saliva and stored in an incubator at controlled temperature of 37°C ± 1. The elastics were then examined in the testing machine to measure the tensile strength degradation.

Results: It was observed through intragroup comparisons that the control and the cola drink showed a progressive statistically significant reduction throughout the study period ($p < 0.001$). In turn, the cold water sample showed a statistically significant reduction in the first and second periods (7 and 14 days). When the test groups were compared with the control, it was observed that all groups presented a reduction in tensile strength statistically significant at 7 and 14 days ($p < 0.001$); however, at 21 days there was no statistical discrepancy between them.

Conclusion: In a laboratory experiment, cola soft drink at 5 ± 1°C contributed statistically ($p < 0.001$) for the strength degradation of the orthodontic chain elastics in the period of 7 and 14 days. Similar results were obtained in specimens immersed cold water, allowing to infer that the composition of the beverage did not promote an extra lowering. It is thus speculated that temperature may be the predominant factor.

Keywords: Orthodontic Elastics; Force Degradation; Tensile Strength

Introduction

Since the beginning of the last century, efforts have been devoted to fundamental research on tooth movement and the design and mechanisms of the orthodontics appliances and accessories have received great interest [1]. The orthodontic movement results from the application of a varied force system composed by springs, wires and/or elastics. The system should be able to transfer strength, promoting movement without discomfort to the patient or damage to the surrounding tissues [2]. The ideal orthodontic force required to achieve tooth movement is controversial, but it is often assumed that slight and continuous forces are considered optimal [3]. In this context, researches aiming at enhancing appliances and accessories performance are continuously expected.

Elastics are amorphous polymers formed of polyurethane material, presenting rubber and plastic characteristics [4,5]. Elasticity is defined as the ability of the elastic to return to its original dimensions when subjected to deformation forces. The type of molecular attraction and the geometric pattern of the polymers determine this property [4], yet factors linked to the intra oral environment such as saliva pH, enzymes, diet, physical action of teeth brushing, temperature variations, water and pigment absorption accelerate elasticity loss and strength degradation [3,5,6].

It is thus speculated that feeding and hygiene particularities can interfere in the elastic properties and affect the treatment outcome. Based on this assumption, researches have been carried out to evaluate force degradation in several conditions related to

individual habits and oral cavity, such as the use of alcoholic beverages [7], chlorhexidine wash in different formulations [2], alcohol concentration in mouthwashes [8] and different diet products [9]. Surprisingly, researches on a worldwide consumed industrial beverage, Coca-Cola® is still lacking. The aim of this study was to evaluate in laboratory the effect of immersion in cola beverage in the tensional strength of orthodontic elastomeric chains.

Material and Methods

For the present investigation, Memory chain (American Orthodontics, Sheboygan, USA) pearl-colored elastomeric chains were used. The segments were carefully removed from the reels without stretch and 5 loops were selected for each sample. Segment cutting was always done in the middle portion of the sixth link, leaving half a link at each of its ends, so that no damage of the structure of the elastic chains occurred during cutting.

The segments were then placed with a mathiew clamp in a previously prepared tube fitting 18 elastic segments each. The custom tubes are made with polyvinyl chloride (PVC) with small holes in a horizontal distance of 0.5 mm between them, for the purpose of inserting support rods made of stainless steel (0.7 mm), which will serve as hooks for the elastic chains setting. The inside part of the tubes is filled with self-curing acrylic resin in order to fix the rods. Therefore, two of the five connections were introduced and distended by a vertical distance of 23.5 mm (Figure 1). This methodology was based on previously published work by Pithon., *et al* [2].

Figure 1: Experiment device for chain elastics setting.

Sample was divided into three groups according to the tested liquids: artificial saliva at 37°C (control group, group 1), cold water at 5°C (group 2) and Coca-Cola® softdrink at 5°C (group 3). The elastics arranged on the tubes were immersed in artificial saliva at a temperature of 37°C for the period of 1h prior to the beginning of the experiments. Then, the tubes were removed from the container with artificial saliva, allowing the saliva to drain, and then immersed in the containers with the liquids to be tested (Figure 2) in which they remained immersed for 30 seconds two times per day, with an interval of 12 hours. After each experiment, samples were totally re-immersed in plastic containers with artificial saliva and kept in an incubator with a temperature of 37 ± 1°C, controlled by a thermostat and digital thermometer, simulating the temperature of the oral cavity. This saliva was changed twice a week. Each liquid had the temperature controlled with a digital thermometer (KT-300, UF Tools, China). The temperature of Coca-Cola® (Group 3) and the ice water (Group 2) was set at 5 ± 1°C.

Figure 2: Chain elastics during immersion.

Specimens were finally removed from the tubes and mounted in testing machine in the intervals of 7, 14 and 21 days. In order to evaluate the strength degradation, the chain elastics were removed from the hooks and placed in the universal calibration machine (AME-2kN; Filizola, São Paulo, Brazil) previously calibrated to the distance of 23.5 mm from the sensors. This setting ensured greater reliability of the data obtained. After each measurement, the machine was restarted and the values were recorded on a control chart.

Statistical Procedures

The assumptions for the use of analysis of variance of repeated measures (homoscedasticity, normality and sphericity) were initially verified. After normality was rejected by means of the Kolmogorov-Smirnov test, non-parametric statistics was employed. The Friedman test was used to evaluate in each group the strength degradation of the orthodontic elastics over time, with the comparisons between the different moments (7, 14 and 21 days) being performed through the Wilcoxon test. The Kruskal-Wallis test was used to test the differences between the groups at each moment, and the comparisons with the control group were performed using the Mann-Whitney test. The level of significance was set at 5% ($\alpha = 0.05$). The data were tabulated and analyzed in IBM SPSS Statistics for Windows (IBM SPSS, 21.0, 2012, Armonk, NY: IBM Corp.).

Results

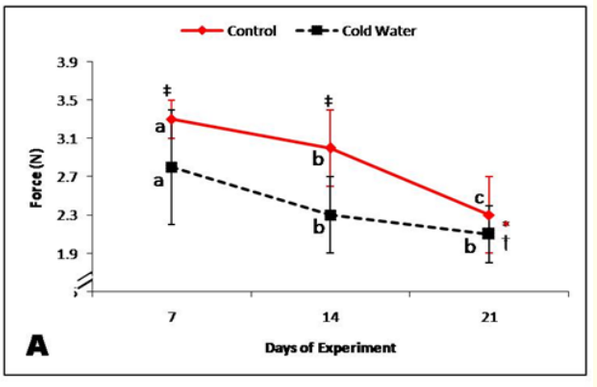
Table 1 shows the median and interquartile range of all groups evaluated. It was observed through the intragroup comparisons that the control group (group 1) and Coca-Cola® (Group 3) presented progressive and statistically significant reduction over the

period evaluated. The elastomeric chains immersed in cold water (group 2) presented a statistically significant reduction in the interval 7 and 14 days stabilizing in the period of 21 days, presenting no statistical difference in this period. When the test groups were compared to the control, it was observed that the groups presented a statistically significant reduction of the tensional force ($p < 0.001$) at 7 and 14 days. However, at 21 days there were no statistical discrepancies between the control group and the test groups.

Group	Days of Experiment			p*
	7 days	14 days	21 days	
Control	3,3 ± 0,2[a]	3,0 ± 0,4[b]	2,3 ± 0,4[c]	< 0,001
Cold Water	2,8 ± 0,6[a‡]	2,3 ± 0,4[b‡]	2,1 ± 0,3[b]	< 0,001
Coca cola®	3,0 ± 0,4[a‡]	2,5 ± 0,3[b‡]	2,1 ± 0,6[c]	< 0,001
p†	< 0,001	< 0,001	0,021	

Table 1: Effect of cold water and Coca Cola® on the strength of orthodontic elastics at the intervals tested. Values are expressed as median ± interquartile deviations. N: Newton; * Friedman test; † Kruskal-Wallis test. a, b, c Values followed by equal horizontal letters (line) do not differ statistically from each other by the Wilcoxon test; ‡ statistically different ($p < 0.05$) from the control group (Mann-Whitney test).

Figure 3A and 3B depict individually the intragroup and intergroup comparisons of the cold water and Coca-Cola® groups, respectively. In figure 3A, it is observed progressive reduction of the tensile strength of the elastics immersed in cold water; however, statistic relevant difference was just observed from the first to the second periods tested ($p < 0.001$). In the comparison with the control, the test group presented statistical differences ($p < 0.001$) at the intervals of 7 and 14 days. In figure 3B, the intragroup comparison shows the progressive and statistically significant reduction ($p < 0.001$) of the tensional force in both groups (artificial saliva and Coca-Cola®). In the comparison with the control group, there was a statistical difference ($p < 0.001$) in the intervals of 7 and 14 days.



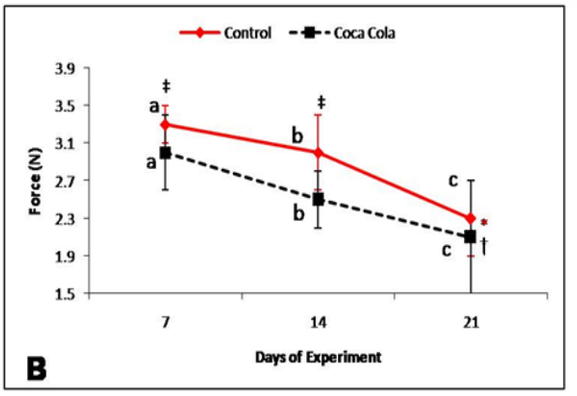


Figure 3: Effect of cold water (A) and Coca Cola® (B) on the strength of orthodontic elastics at the intervals tested. Values are expressed as median ± interquartile deviations. N=Newton; * Friedman test; † Kruskal-Wallis test. [a, b, c] Values followed by equal horizontal letters (line) do not differ statistically from each other by the Wilcoxon test; ‡ statistically different ($p < 0.05$) from the control group (Mann-Whitney test).

Discussion

In Orthodontics, a varied sort of elastics is employed. The elastomeric chains are fabricated as a connected elastic chain reel, which can be cut to the specific number of necessary links [8]. The elastomeric chains are useful and convenient in many situations [4,10,11]. The stretched chain provides elastic potential energy that can be converted into mechanical energy, thus promoting tooth movement [5].

Several advantages are attributed to elastics such as low cost, satisfactory biocompatibility, high flexibility, color diversity, relative ability to maintain forces after distortion and good tolerance by patients. Elastic chains are easily applied and removed and do not require patient cooperation. Moreover, does not impair hygiene or oral and phonetic functions [12,13]. In some circumstances; however, elastics show rapid tensile force degradation, thus compromising the treatment outcome [3]. In this context, studies are anticipated for better understanding of elastics behavior in varied oral conditions and the present study aimed at researching the effect of Coca-Cola®, the world's most widely consumed industrial beverage.

The results demonstrated that over time all groups presented reduction of elastic force. It was observed through intragroup comparisons that the control and the cola drink immersed elastics showed a progressive reduction and statistically significant throughout the study period ($p < 0.001$). In turn, the cold water sample showed a statistically significant reduction in the first and second periods (7 and 14 days). The tension loss is observed clini-

cally and explained in several studies as an intrinsic property of elastics [12]. The present study revealed; however, that immersion in the tested liquids accelerated the reduction of the tensile force in a statistically significant manner ($p < 0.001$) at moments 7 and 14 days, comparing to the control. At 21 days, there was a more abrupt drop in the tension of the elastics in the control group, approaching the values of the test groups, which continued to decrease practically linear. At 21 days there was no statistical discrepancy between the groups tested. This finding resembles the work of Pithon., *et al.* [7] in which immersion in alcoholic drinks did not produce statistical differences when compared to the control group at the end of the experiment.

Regarding the use of Coca Cola®, two previous studies could be found [9,14]. However, due to complete different methodology and objectives, the results are not suitable for comparison with the present study. Varied experimental methods and elastics features, such as different chain size and brands, static or dynamic stretching, stretch length or pre-stretching (among other variables), make the comparisons impossible. The diversity of variables provides distinct results when assessing the degree of force degradation; moreover, it is considered very difficult to control all factors that can influence the results [3].

Employing very similar methodology, a previous study [7] evaluated the effect of immersion in whisky, brandy, vodka, beer, sugar cane spirit, and wine. Authors showed that none of the aforementioned alcoholic beverages promoted loss of strength in the elastic chains. Other research [2] with similar methods revealed that chlorhexidine at different concentrations did not influence the elastic strength degradation. Finally, regarding the use of mouthwash with or without bleaching agent, a previously published article reported no effect on the force degradation of elastomeric chains [15].

Considering the physiology of tooth movement and taking into account that the chain elastics cannot produce constant levels of force over a long period of time, the present study aimed at evaluating the 21 days period, that is the usually recommended interval between orthodontic appointments [6,11]. Researches published previously also utilized same protocol [11,14], although is also available in the literature studies with longer testing periods [2,5-8]. Throughout the research, samples were kept in an incubator at 37 ± 1°C immersed in artificial saliva. This care is essential to keep the laboratory study as close as possible to oral conditions and also not to produce results that could be influenced by other variables.

The present study standardized the test beverages at 5 ± 1°C, which is the approximate usual temperature of refrigerated beverages consumption. The objective was also to verify the effect of this temperature on the behavior of the elastics. With this purpose, cold water group was included, since cola soft drink varies greatly in pH when the temperature changes. Assuming that water is an inert substance, the comparisons of the control group with the cold water, in the present study, showed that the temperature promoted decrease statistically significant of the tensile strength in the intervals 7 and 14 days. Similar results were obtained in specimens immersed in Coca-Cola®, allowing to infer that the composition of the beverage did not promote an extra lowering. It is thus speculated that temperature may be the predominant factor. No studies involving the temperature were found in the literature for proper comparison, and further studies are needed to elucidate this question. In addition, the present study is a laboratory research and in the oral environment other decisive factors may be involved, causing the present result to be interpreted with caution. Moreover, only 2 exposures of 30 seconds per day were performed; however, in the daily routine, time of liquid contact with mouth can vary greatly depending on the individual habits.

Finally, it is important for the orthodontist to understand the behavior of the materials to achieve appropriate clinical outcomes. Although the reduction of the groups was progressive in this study, all the elastics still showed at the end of the experiment tensional force and were, therefore, indicated for use. More clinical studies are needed to investigate whether the strength degradation observed in the present study has any implication in the treatment.

Conclusion

In a laboratory experiment, Coca Cola® at 5 ± 1°C contributed statistically ($p < 0.001$) for the strength degradation of the orthodontic chain elastics in the period of 7 and 14 days. Similar results were obtained in specimens immersed cold water, allowing to infer that the composition of the beverage did not promote an extra lowering. It is thus speculated that temperature may be the predominant factor.

Bibliography

1. Moris A., *et al*. "Estudo in vitro da degradação da força de elásticos ortodônticos de látex sob condições dinâmicas". *Revista Dental Press de Ortodontia e Ortopedia Facial* 14.2 (2009): 95-108.

2. Pithon MM., *et al*. "Does chlorhexidine in different formulations interfere with the force of orthodontic elastics?" *The Angle Orthodontist* 83.2 (2013): 313-318.

3. Motta AFJ., *et al*. "Avaliação in vitro da força liberada por elásticos em cadeia". *Dental Press Journal of Orthodontics* 16.6 (2011): 36-37.

4. Alexandre LP., *et al*. "Avaliação das propriedades mecânicas dos elásticos e cadeias elastoméricas em orthodontia". *Revista Odonto Ciencia* 16.32 (2008): 53-63.

5. Yagura D., *et al*. "Deformation of elastomeric chains related to the amount and time of stretching original". *Dental Press Journal of Orthodontics* 18.3 (2013): 136-142.

6. Weissheimer A., *et al*. "In vitro evaluation of force degradation of elastomeric chains used in Orthodontics". *Dental Press Journal of Orthodontics* 18.1 (2013): 55-62.

7. Pithon MM., *et al*. "Do alcoholic beverages interfere in the force of orthodontic elastics?" *Revista de Odontologia da UNESP* 43.3 (2014): 191-195.

8. Larrabee TM., *et al*. "The effects of varying alcohol concentrations commonly found in mouth rinses on the force decay of elastomeric chain". *The Angle Orthodontist* 82.5 (2012): 894-99.

9. Beattie S and Monaghan P. "In vitro study simulating effects of daily diet and patient elastic band change compliance on orthodontic látex elastic". *The Angle Orthodontist* 74.2 (2004): 234-239.

10. Araujo FBC and Ursi WJS. "Estudo da degradação da força gerada por elásticos ortodônticos sintéticos". *Revista Dental Press de Ortodontia e Ortopedia Facial* 11.6 (2006): 52-61.

11. Kochenborger C., *et al*. "Avaliação das tensões liberadas por elásticos ortodônticos em cadeia: estudo in vitro". *Dental Press Journal of Orthodontics* 16.6 (2011): 93-99.

12. Martins MM., *et al*. "Elásticos ortodônticos em cadeia: revisão de literatura e aplicações clínicas". *Revista Dental Press de Ortodontia e Ortopedia Facial* 5.5 (2006): 71-78.

13. Martins MM. "Estudo comparativo entre as diferentes cores de ligaduras elásticas". *Revista Dental Press de Ortodontia e Ortopedia Facial* 11.4 (2006): 81-90.

14. Teixeira L., *et al*. "The environmental influence of Light Coke, phosphoric acid, and citric acid on elastomeric chains". *Journal of Contemporary Dental Practice* 9.7 (2008): 17-24.

15. Pithon MM., *et al*. "Do mouthwashes with and without bleaching agents degrade the force of elastomeric chains?" *Angle Orthodontist* 83.4 (2013): 712-717.

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