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A study to evaluate experimentally the effect of hot water, hot green tea, and hot coffee on the tensional strength of orthodontic elastomeric chains

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***Abstract*---**Background: The shape memory quality of elastomeric chains makes them useful in orthodontic mechanics, however elastomers also provide significant force reduction in specific instances. Researchers were looking for a correlation between hot drinks and elastomeric chain deformation. Material and Methods: Using various immersion liquids (artificialsaliva, hot water, green tea, and coffee), four groups were evaluated (group 4). It took 7, 14, or 21 days for the elastomeric chains of groups 2, 3, and 4 to reach 70 ±1°C when submerged in the appropriate liquids for 30 seconds twice daily. All samples were preserved in artificial saliva and maintained at a constant 37±1°C temperature in an incubator for long periods of time. Finally, the elastomeric chains were tested for tensile strength

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deterioration, as well as other properties. Results: Through intragroup comparisons, it was shown that the control demonstrated a statistically significant decrease in tensile strength during the course of the research. When it came to hot water and green tea, the results revealed a statistically significant decrease over the course of seven to fourteen days. The tense atmosphere persisted for a period of 14 to 21 days. Except for the coffee group at 21 days ($P < .001$), all groups tested showed statistically significant reductions in tension when compared with the control. Conclusion: After seven and fourteen days of exposure to 70°C hot water, green tea, and coffee, there was statistically significant degradation of orthodontic elastomeric chains.

***Keywords*---**Orthodontic elastomeric chains, orthodontics, tensile strength

Introduction

In orthodontics, elastic chains are utilized for a variety of functions, including the closing of spaces. Their cheap cost, sanitary nature, and ease of application make them a popular choice. Despite the benefits of elastomeric chains, their characteristics may be changed by heat and moisture. Orthodontic appliances in the mouth are exposed to heat, chemical, and mechanical modifications over lengthy periods of time, which may lead to their deterioration. Elastomeric chains have previously been studied in terms of their force decay patterns and the influence of environmental conditions. The characteristics of elastomeric chains are altered by salivary enzymes and masticatory force. A wide range of environmental conditions, including changes to temperature and pH, have also been researched in relation to elastomeric materials' characteristics. In order of importance, the following are: Thus, it has been hypothesized that feeding and hygiene specifics may interfere with the elastic characteristics of the material and impact the therapy outcomes. High-temperature eating behaviors, on the other hand, have not been studied. 9-18 In most nations, hot drinks are a popular choice, and it is not hard to see why. Consider the possibility that this drinking pattern might have an impact on orthodontic outcomes in the context of this discussion. An investigation into how hot water, hot green tea, and coffee affect the elasticity of orthodontic elastomeric chains was the goal.

Material and Methods

We employed 3M Unitek (Monrovia, California) elastomeric chains for this experiment. Five loops were picked from each sample and carefully removed from the reels without stretching. By cutting segments in the centre of each sixth link and leaving a half-link at either end, the elastomeric chain structure was spared any harm during the cutting process. Finally, the segments were inserted into the tube using a Mathew clamp, with each segment containing 18 elastic segments. With 0.5 mm spacing between the polyvinyl chloride tubes, stainless steel rods (0.7 mm) may be inserted to function as hooks for the elastic chains, which are attached to the tubes using the tiny holes. A self-curing acrylic resin is used within the tubes to hold the rods in place. 23.5 mm will be added to 2 of the 5 connectors to make them more flexible. Pithon et al. had previously developed an approach that was used in this study. A total of four sets of samples were created, each with a different temperature range for the testing liquids: 37°C for artificial saliva in the controls (group 1), 70°C for boiling water in groups 2, 70°C for boiling green tea in groups 3, and 70°C for boiling black coffee in groups 4 and 5. (group 4). At 37°C for one hour prior to the experiment, the elastomeric chains attached to tubes were submerged in artificial saliva. To test the liquids, tubes were withdrawn from the container of artificialsaliva, which had been drained, and then submerged twice daily in containers containing the liquids to be tested. An oral cavity-like temperature of 37°C 1°C was maintained in an incubator after each experiment by using a thermostat and digital thermometer to maintain samples completely submerged in plastic containers with artificial saliva. Every two weeks, the saliva was replaced. A digital thermometer was used to regulate the temperature of each liquid. At 70± 1°C, the temperature of the heated liquids was established. It was eventually determined that the specimens were collected from the tubes at intervals of 7, 14, and 21 days. "Using a universal calibration machine previously calibrated to a distance of 23.5 mm from the sensors, elastomeric chains were removed from the hooks and analyzed for the loss of strength. The data was more accurate as a consequence of this setup. It was restarted after each measurement and findings were recorded on a control chart. During this experiment, we used specially prepared artificial saliva. Sodium bicarbonate 2.19 mg, potassium phosphate monobasic 12.7 mg, magnesium chloride 1.25 mg, calcium chloride 4.41 mg, potassium chloride 8.2 mg, sodium fluoride 0.045 mg, sodium benzoate 15 mg, 70 percent sorbitol 0.24 g, carboxymethylcellulose 0.06 g, and distilled water 1000 mL were the ingredients in the composition."For green tea, water was heated to boiling point, and then the leaves were put to it. Finally, tea bags were placed in a teapot with the necessary quantity of water and switched on in accordance with the manufacturer's instructions When the tea reached 70 ±1°C, it was allowed to cool down for a few minutes. Once the mixture had been transported to the experimental container, it was submerged together with the test specimens.A disposable paper filter was used to brew coffee in the same way as it was made in the past. Powder/water ratio was determined by following manufacturer's instructions.

Statistical Procedures

The assumptions of homoscedasticity, normality, and sphericity for the use of analysis of variance of repeated measurements were originally validated before moving further with the study. Nonparametric statistics were used when the Kolmogorov-Smirnov test was used to reject normality. The Friedman test was used to compare the strength degradation of orthodontic elastomeric chains over time in each of the three time periods studied (7, 14, and 21 days). Kruskal-Wallis analysis was used since no differences were discovered between groups at any given moment in time. Hence, "Table 1. Effect of Hot Water, Hot Green Tea, and Hot Coffee on the Strength (Newtons) of Orthodontic Elastics at the Intervals Tested" for comparison, a Mann-Whitney test was used. Five percent (α=.05) is considered statistically significant in this study. IBM SPSS Statistics for Windows was used to tabulate and evaluate the results (IBM SPSS, 21.0, 2012, Armonk, NY: IBM Corp.).

Results

For each category, the median and interquartile range are shown in Table 1. A statistically significant decrease in the control group was seen during the course of the trial, as shown by intragroup comparisons. On the other hand, there was a statistically significant decrease from 7 to 14 days in the hot water, green tea, and coffee samples (P =.001). There was no change in the level of stress between days 14 and 21. Except for the coffee group after 21 days, all of the groups tested showed statistically significant reductions in tension when compared to the control.

Days of experiment				
Group	7 days	14 days	21 days	P*
Control	3.4 ± 0.2^{a}	3.1 ± 0.4^{b}	2.4 ± 0.4^{c}	<.001
Hot water	$2.5\pm0.4^{a\#}$	$2.3\pm0.5^{b\#}$	$2.1\pm0.3^{b\#}$	<.001
Hot green tea	$2.9\pm0.3^{a\#}$	$2.0\pm0.5^{b\#}$	$1.7\pm0.6^{b\#}$	<.001
Hot coffee	$2.7\pm0.5^{a\#}$	$2.2\pm0.5^{b\#}$	2.1 ± 0.3^{b}	<.001
P**	<.001	<.001	.028	

Discussion

In orthodontics many materials such as arch wire loops, coil springs, latex elastics and synthetic elastomers are used to apply force to move the teeth. Elastics and elastomerics are used as an active component of orthodontic treatment such as retraction, cross-bite correction, space closure [7]. Force degradation happens over time among most types of traction aids are currently available. In oral cavity various factors can influence on force generation and force degradation of traction aids, such as saliva, temperature fluctuation, pH variation, fluoride ions release, oxygen content, free radicals, salivary enzymes and masticatory forces [11]. In the mouth, elastics experience constant force expression, with considerable force decay through the first day of use. Most of it being in the first hour of the use. Lumen size influences force decay with smaller size needing to be renewed more often to maintain planned force application [12]. It is easy for the environment to change the chemical structure of a power chain due to variables such as temperature, humidity, and other substances (enzymes and saliva). Elastic force decreased with time for all groups, as seen by the data. Comparative analyses revealed a persistently substantial decline in the control group across the study's whole period of conduct (P <.001). The heated liquid samples, on the other hand, showed a considerable and statistically significant drop between 7 and 14 days, and remained stable from 14 to 21 days. Elastin has been shown to have the ability to do this clinically as well as in other scientific studies. A statistically significant (P<.001) difference was seen between the experimental and control groups when it came to the rate of tensile force loss over the course of seven and fourteen days after immersion. As of 21 days, those elastics in the control group began to shrink more rapidly than those in the test groups, which continued to diminish in strength over time. After 21 days, the tension was still significantly decreased in the hot water and green tea samples.Coffee and control groups did not vary significantly from each other throughout the final session. In the area of alcoholic drinks, elastomeric chains were explored by Pithon et al.7. When comparing the experimental and control groups, no statistically significant differences were found. A study looked at the effect of cola soft drinks on the tension force of orthodontic elastomeric chains. After 7 and 14 days of exposure to temperatures of 5 ±1 °C, Coke soft drink had a statistically significant influence on the degeneration of the orthodontic elastic chains. To rule out any further effects of the beverage's composition, the identical results were obtained with samples immersed in cold water. As a result, the idea was floated that the temperature in the surrounding area could be the most critical factor. 14 When the temperature of the environment rises, polyurethane elastomers' mechanical properties begin to degrade, according to a study by Stevenson et al 15. Since elastomeric chains are unable to maintain continuous force over an extended period of time, it was chosen to explore the 21-day interval between orthodontic appointments. Hot beverages are often served at 70± 1°C, which is considered the average serving temperature in this study. In order to determine whether the temperature had an effect on the elastics' behavior, this experiment was undertaken. As a result of this endeavor, the hot water group was involved When comparing the control group to the hot water group, this study demonstrated statistically significant losses in tensile strength if water is an inert substance. Experiments on specimens bathed in hot green tea and coffee had similar results in terms of decreasing blood pressure. Consequently, it has been suggested that temperature may be the most crucial factor. Since no studies have been done to compare the effects of temperature, further research is required to fully answer this subject. 11-17 In addition, since this research was conducted in a laboratory and not in a real-world setting, it is important to proceed with care when interpreting the findings. The duration of liquid contact with the mouth in everyday life might vary substantially based on an individual's habits, even though just two exposures of 30 seconds each were conducted. Finally, the orthodontist must be aware of the behavior of the materials in order to produce the best possible clinical results. In order to determine whether the strength decline seen in the current research has any bearing on the therapy, more clinical trials are required.

Conclusion

Our findings suggest that immersing orthodontic elastomeric chains in steaming hot water, hot green tea, and hot espresso at a temperature of 70 ±1°C for 7 and 14 days contributed significantly to the degradation of their strength.

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