Received: 4th December 2013 Accepted: 2nd March 2014 Conflict of Interest: None

Source of Support: Nil

Original Research

Effect of Commonly Used Beverage, Soft Drink, and Mouthwash on Force Delivered by Elastomeric Chain: A Comparative *In Vitro* Study

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How to cite the article:

Kumar K, Shetty S, Krithika MJ, Cyriac B. Effect of commonly used beverage, soft drink, and mouthwash on force delivered by elastomeric chain: A comparative *in vitro* study. J Int Oral Health 2014;6(3):7-10.

Abstract:

Background: The objective was to evaluate and compare the effect of Coca-Cola®, tea, Listerine® mouthwash on the force delivered by elastomeric chain *in vitro*.

Materials and Methods: Four specimen groups (distilled water, Coca-Cola®, tea, Listerine® mouthwash) with a total sample size of 480 specimens. A specimen is described as a four link grey close elastomeric chain. Jigs, each with a series of pins set 25 mm apart, was used to hold stretched elastomeric chains at a constant length. These jigs allowed for complete submersion of the elastomeric chain in a water bath throughout the test period, as well as the dipping of elastomeric chains in respective control and test solutions. For 60 s, twice a day, groups were exposed to the respective solutions, the two daily exposure was separated by 9 h and force measurements were taken at six time points during the experiment, that is, 1 h, 24 h, 7 days, 14 days, 21 days, and 28 days. Force measurements were made by Instron machine by a single blinded examiner with the help of a second examiner.

Results: It was found out that there was highly significant difference between groups control, Coca-Cola®, Listerine®, and tea as well as there was highly significant ($p < 0.01$) between time periods. Group versus time was also highly significant ($p < 0.01$). For all groups substantial amount of force decay occurred until 7 days. The control group reached plateau between 7 and 14 days and then suddenly decreased from 14 days to 28 days. The Coca-Cola® and the Listerine® group reached a plateau between 7 and 21 days then decrease between 21 and 28 days. The tea group showed plateau phase between 7 and 28 days. After 28 days in the control group, 25% force decay occurred while the test groups force decay of 30-50% occurred.

Conclusion: Coca-Cola®, Listerine® mouthwash, and tea cause an increase in force decay of elastomeric chains over time. Tea caused highest force decay followed by Listerine® and Coca-Cola® when compared to control group.

Key Words: Beverage, elastomeric chains, force decay, mouthwash

Introdution

Space closing systems in common use include elastomeric products, such as elastomeric chain and modules, and nickel titanium coil springs. It is well-known those elastomeric products lose force over time, even under dry conditions, and that properties are modified by both moisture and temperature.[1]

During stretching, the material is subjected to instantaneous elastic deformation. As the load is maintained, there is a retarded elastic deformation as well as a viscous deformation producing permanent elongation.[2]

Coke has been the most used soft drink in the world.[3] Tea is also one of the most used beverage worldwide.[4]

Many studies have been carried out to study the effect of various environmental factors on force of elastomeric chain.[5] Various factors have been shown to impact the amount of force decay observed with elastomeric chains. In dry air, percentage of force decay after 21 days after 21 days was illustrated to be 42-63% depending on the product brand.[6] Elastomeric chains yielded a significantly greater force decay rate in basic pH solution than acidic pH solution.[7]

However, no previous studies compared the effect of beverages, soft drink, and mouthwash (commonly used fluids by orthodontic patients) on force decay of elastomeric chains.

Hence, this study was carried out to evaluate and compare the effect of Coca-Cola®, tea, Listerine® mouthwash on the force decay of elastomeric chain.

Materials and Methods

Four specimen gro ups (Table 1) (distilled water, Coca-Cola®, tea, Listerine® mouthwash) with a total sample size of 480

Table 1: Experimental design.

Time points	Control	Coca-Cola®	Listerine®	Tea
Initial	20 specimens	20 specimens	20 specimens	20 specimens
1 day	20 specimens	20 specimens	20 specimens	20 specimens
7 days	20 specimens	20 specimens	20 specimens	20 specimens
14 days	20 specimens	20 specimens	20 specimens	20 specimens
21 days	20 specimens	20 specimens	20 specimens	20 specimens
28 days	20 specimens	20 specimens	20 specimens	20 specimens

specimens. A specimen is described as a four link grey close elastomeric chain.

Materials included

- Grey closed elastomeric chain (Alastik, 3M Unitek) (Figure 1).
- Coca-Cola®.
- Listerine® mouthwash.
- Tea.
- Jigs with pins set 25 mm apart (12 jigs per group) (Figure 2).
- Instron testing machine.

Methodology

Jigs, each with a series of pins set 25 mm apart, was used to hold stretched elastomeric chains (four link) at a constant length. These jigs allowed for complete submersion of the elastomeric chain in a water bath throughout the test period, as well as the dipping of elastomeric chains in respective control and test solutions (Coca-Cola®, Listerine® mouthwash, and tea) (Figure 3). For 60 s, twice daily, control and test groups were exposed to the respective solutions, the two daily exposure was separated by 9 h and force measurements was taken at six time points during the experiment, that is, 1 h, 24 h, 7 days, 14 days, 21 days, and 28 days. Each 60 s exposure was measured using a digital clock.

After being submerged in the respective solutions, specimens were dipped in separate, intermediate artificial saliva for 10 s to simulate salivary rinsing of the fluid from the oral cavity, and then placed back into their 37°C water bath. The control group underwent the same protocol; however, these elastics were only exposed to distilled water.

Force measurements (in N) were made by Instron machine (3M lab) by a single blinded examiner with the help of a second examiner (Figure 4). After each measurement the force measurement reading was made to zero. Each specimen was connected to a pair of hooks and stretched to a distance of 25 mm between the hooks on the Instron testing machine. They were left undisturbed for 1 mi, whilst the residual force within the specimen was recorded. The elastics were positioned by one examiner and readings made by a second examiner. All chains were maintained in the same manner at the same vertical distance to ensure consistent measurements.

Statistical analysis

The effects of group (distilled water, Coco Cola®, Listerine® mouthwash, tea) and time (initial, 24 h, 7, 14, 21, and 28 days)

Figure 1: Elastomeric chain.

Figure 2: Jig containing E chains.

Figure 3: Jigs dipped in their respective solutions.

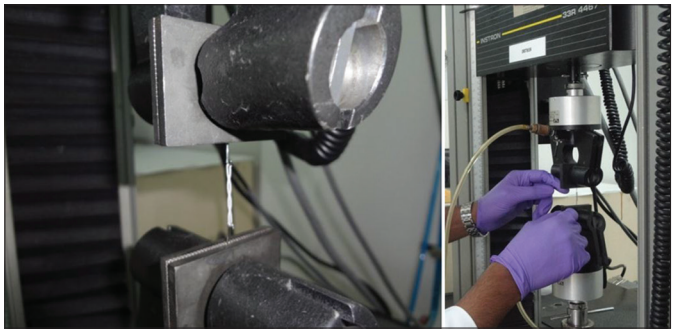

Figure 4: Specimen loaded on Instron machine.

Table 2: Force measurements and percentage decay (compared to initial).

Group	Time (days)	Mean (*N*) (force decay, %)	Standard deviation
1 - Coca-Cola®	0.00	5.2322	0.16375
	1.00	4.8393 (7.5)	0.13909
	7.00	4.5805 (12.36)	0.12398
	14.00	4.4708 (14.56)	0.11090
	21.00	4.3805 (16.28)	0.12083
	28.00	4.0663 (22.37)	0.12312
2 - Listerine®	0.00	5.2387	0.10296
	1.00	4.7456 (9.41)	0.10196
	7.00	4.4635 (14.79)	0.31272
	14.00	4.3200 (17.53)	0.11013
	21.00	4.2358 (19.14)	0.08689
	28.00	4.0255 (23.15)	0.08480
3 - Tea	0.00	5.0685	0.33743
	1.00	4.0919 (19.27)	0.31568
	7.00	3.1390 (38.06)	0.21438
	14.00	2.8772 (43.23)	0.12195
	21.00	2.6904 (46.92)	0.13431
	28.00	2.5659 (49.30)	0.10145
4 - Control	0.00	5.3507	0.11301
	1.00	5.1939 (4.71)	0.08780
	7.00	4.9024 (10.05)	0.11895
	14.00	4.7598 (12.67)	0.09470
	21.00	4.2796 (21.48)	0.16857
	28.00	4.1104 (22.18)	0.09287

on force were analyzed with a two-way analysis of variance (Table 2). Pair-wise comparisons were conducted using Tukey's analysis.

Results

It was found out that there was highly significant difference between groups control, Coca-Cola®, Listerine®, and tea as well as there was highly significant ($p < 0.01$) between time periods. Group versus time was also highly significant ($p < 0.01$) (Table 3).

Force decay increased in control, Coca-Cola®, Listerine®, and tea over time. All test groups showed significantly increased force decay compared with control and each test group compared to control in following ways (Table 2 and Figure 5).

Force decays increased in all groups through 7 days then the increase was not much.

When comparing test groups (Table 4), the results were statistically significant ($p < 0.01$).

When comparing time within each group, in Coca-Cola® group, the results when comparing 7th and 14th day, 14th and 21st day were not statistically significant. Similarly in Listerine® group also the results were statistically significant except when comparing 7th and 14th days and 14th and 21st day. In tea group, when comparing 14th day and 21st day, 21st and 28th day the results were not statistically significant.

Table 3: Group versus time (force measured in N).

Group	Time	Mean	Standard error
1	0.00	5.232	0.036
	1.00	4.839	0.036
	7.00	4.580	0.036
	14.00	4.471	0.036
	21.00	4.381	0.036
	28.00	4.166	0.036
2	0.00	5.239	0.036
	1.00	4.746	0.036
	7.00	4.464	0.036
	14.00	4.320	0.036
	21.00	4.236	0.036
	28.00	4.026	0.036
3	0.00	5.069	0.036
	1.00	4.092	0.036
	7.00	3.139	0.036
	14.00	2.877	0.036
	21.00	2.690	0.036
	28.00	2.566	0.036
4	0.00	5.451	0.036
	1.00	5.194	0.036
	7.00	4.902	0.036
	14.00	4.760	0.036
	21.00	4.280	0.036
	28.00	4.110	0.036

Table 4: Tests of between-subjects effects.

Source	Type III sum of squares	Df	Mean square	*F*	Significant
Group	140.343	3	46.781	1774.905	0.000
Time	128.706	5	25.741	976.639	0.000
Group*time	26.942	15	1.796	68.146	0.000
Total	9291.652	480			

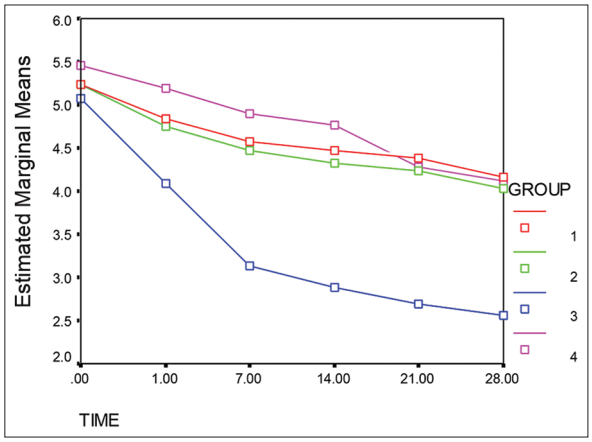

Figure 5: Estimated marginal means of TOT.
1 - Coca Cola®, 2 - Listerine®, 3 - Tea, 4 - Control.

Discussion

The results of this study confirm that when compared to control, all test specimens showed statistically significantly increased force decay. The results also confirm previous studies[8-13] showing force decay over time, which is highly initial and then reaches a plateau.

For all groups substantial amount of force decay occurred until 7 days.

The control group reached plateau between 7 and 14 days and then suddenly decreased from 14 days to 28 days. The Coca-Cola® and the Listerine® group reached a plateau between 7 and 21 days then decrease between 21 and 28 days. The tea group showed plateau phase between 7 and 28 days. However compared to other groups, tea group showed much higher force decay from initial to 7 days, this can be owing to temperature of the tea.

Certain inconsistent force decay was seen in some groups. While the elastics used in this study were all selected from the same manufacturer, there seemed to be variation between individual elastics. The inconsistent force decay seen in some groups could be attributed to the fact that there could be unequal material exposure.

After 28 days, the control group had 22% force decay occurred, while the test groups had 25-50% force decay. Because neither tea, Coca-Cola® nor Listerine® mouthwash result in total force decay over 28 days, usage of these drinks and fluids does not have a detrimental effect on elastomeric chains.

However, research is clear that elastomeric chains studied *in vivo* have significantly more force decay than those *in vitro*.[1,8-10] Studies have shown that in vivo greatest per cent of force decay occurs during first day.[9,14] Further studies can be conducted to ascertain the degree of E chain force decay observed *in vivo*. In a study among the variables studied, increase in temperature of environment appeared to significantly influence the degradation mechanism responsible for deterioration of elastomers; acidity and oxtgen content had no significant effects.[15]

Studies have also shown greater the amount of pre-stretching greater the amount of force loss observed and greater the initial force applied greater the force decay.[10,16,17] Until research can demonstrate otherwise, the current practice of changing elastomeric chains every 21-28 days seems acceptable from the perspective of performance of dental materials.

Conclusion

- Coca-Cola®, Listerine® mouthwash, and tea cause an increase in force decay of elastomeric chains over time.
- Tea caused highest force decay followed by Listerine® and Coca-Cola® when compared to control group.

References

1. Natrass C, Ireland J, Sheriff M. The effect of environmental effect on elastomeric chains and Niti coil springs. Eur J Orthod 1998;20:169-76.
2. Eliades T, Eliades G, Silikas N, Watts DC. Tensile properties of elastomeric chains. Eur J Orthod 2004;26:157-62.
3. Available at http://www.energyfiend.com/top-10-soft-drinks [Last accessed on 2013 Nov 14].
4. Available at http://www.ibtimes.com/tea-or-coffee-which-indias-national-drink-1255279# [Last accessed on 2013 Nov 14].
5. Larabee TM, Liu SS, Torres-Gorena A, Soto-Rojas A, Eckert GJ, Stewart KT. The effects of varying alcoholic concentration in mouthwashes on the force decay of elastomeric chains. Angle Orthod 2012;82:894-9.
6. Ren Y, Maltha JC, Kuijpers-Jagtman AM. Optimum force magnitude for orthodontic tooth movement: a systematic literature review. Angle Orthod 2003;73:86-92.
7. Ferriter JP, Ferriter JP, Meyers CE, Lorton L. The effect of hydrogen ion concentration on force degradation rate of orthodontic chain elastics. Am J Orthod Dentofacial Orthop 1990;98:404-10.
8. Ash JL, Nikolai RJ. Relaxation of orthodontic elastomeric chains and modules *in vitro* and *in vivo*. J Dent Res 1978;57:685-90.
9. Kuster R, Ingervall B, Burgin W. Laboratory and intra-oral tests of the degradation of elastic chains. Eur J Orthod 1986;8:202-8.
10. Lu TC, Wang WN, Tarng TH, Chen JW. Force decay of elastomeric chain – a serial study. Part II. Am J Orthod Dentofacial Orthop 1993;104:373-7.
11. Killiany DM, Duplessis J. Relaxation of elastomeric chains. J Clin Orthod 1985;19:592-3.
12. Wong AK. Orthodontic elastic materials. Angle Orthod 1976;46:196-205.
13. Taloumis LJ, Smith MT, Hondrum SO. Force decay and degradation of orthodontic elastomeric ligature . Am J Orthod 1997;111:1-11.
14. Andreasen GF, Bishara S. Comparison of Alastik chains with elastics involved with intra-arch molarto-molar forces. Am J Orthod 1970;40:151-8.
15. Stevenson JS, Kusy RP. Force application and decay of untreated and treated polyurethane elastomeric chains. Angle Orthod 1994;64(6):455-67.
16. Young J, Sandrik JL. The influence of preloading on stress relaxation of orthodontic elastic polymers. Angle Orthod 1979;49:104-9.
17. Kim KH, Chung CH, Choy K. Effects of prestretching on force degradation of synthetic elastomeric chains. Am J Orthod Dentofacial Orthop 2005;128:477-82.