EFFECT OF AERATED DRINKS ON FORCE DECAY PROPERTIES OF ELASTOMERIC CHAINS: AN IN VITRO STUDY

Reena R. Kumar,[1] Mayank Gahlot,[2] Nameeta Kaur,[3] Anil Miglani[4]

[1]Professor & Head, [2]Post Graduate Student, [3]Senior Lecturer, [4]Professor
Department of Orthodontics & Dentofacial Orthopaedics
D.J. College of Dental Sciences & Research, Modinagar, India

Email : drreena1296@rediffmail.com

ABSTRACT

Objective: To evaluate the effect of three commercially available aerated drinks on percentage of force decay of elastomeric chains used for orthodontic space closure. **Materials & Method**: Commercially available closed grey and clear elastomeric chains from two manufacturers were used in the study. The test solutions were distilled water (control), popular lemon based aerated drink, an orange based aerated drink and an aerated cola drink. Four acrylic resin jigs were constructed to provide a framework to simulate the distance between the permanent canine and first molar. The elastomeric chains were stretched and engaged between the two attachments. Jig I, II and III were immersed in the cola, orange and aerated lemon drink respectively for a period of two hours daily. Jig IV (control) was immersed in distilled water. Force levels were evaluated at the time intervals of 0 hours, 2 hrs, 12 hrs, 24 hrs, 3 days, 5 days and 7 days with a mechanical force gauge. **Result:** Force decay was statistically significant at T_1 i.e. 2 hrs post immersion for all drinks compared. This decay was the highest for the elastomeric chains immersed in orange based drink followed by cola, lemon and the control. There was no significant difference between the two tested elastomeric chains. **Conclusion:** History recording should take cognizance of consumption of aerated drinks and their effect on orthodontic space closure.

Key Words: Aerated drinks, Elastomeric chain, Force decay

INTRODUCTION

Elastomeric chains were introduced to the dental profession in the 1960s and have since been used extensively in orthodontics for space management.[1] They have the advantage of being relatively inexpensive, easily applied and obviate patient cooperation.

Elastomeric chains are polyurethanes, thermosetting polymer products of a step-reaction polymerization process with a Hydroxyl bond.[1] These chains are fabricated either by die-cut stamping or injection molding technique and are commercially available in varying diameter and configuration, with or without pigments.[2] As the elastomeric chains are continuously exposed to the oral environment, their properties may be degraded due to saliva and related extrinsic abuses within the oral cavity.

Presently the orthodontic clientele; be it urban or rural, are exposed to the concept of consuming popular aerated drinks in moderate to large quantities in keeping with the current trend of fast food culture.

This in vitro study was aimed to ascertain if aerated drinks would affect the force decay properties of commercially available elastomeric chains. The null hypothesis drawn for this study was that there would be no effect on the force decay properties of grey and clear elastomeric chains exposed to lemon, orange & cola based aerated drinks.

MATERIALS AND METHOD

Clear Closed elastomeric chains from ORMCO (Ormco, Glendora, California, USA) labeled as Sample 1, and closed grey Rabbit Force (Rabbit Force elastomeric chains, USA) as Sample 2, were included in the study.

Distilled water (control), popular cola, lemon and orange based drinks (from the same manufacturer) which have availability pan-India were used in the study. The pH of the

drinks was recorded with the help of a pH meter (Fig. 1). The pH was 3.4 for cola, 3.0 for orange and 4.08 for the lemon-based aerated drink. This was confirmed from the official website of the manufacturer.

Four rectangular, acrylic resin jigs (Fig. 2) were constructed to provide a framework for the simulated space closure mechanics. Each jig comprised of two halves of an acrylic plate, fabricated in separate colors. Each half of the jig consisted of a canine bracket and a molar tube bonded on to it and separated by a distance of 25 mm, to represent the spatial relation between the first molar and canine in a bicuspid extraction case.

Fig. 1 : pH Meter

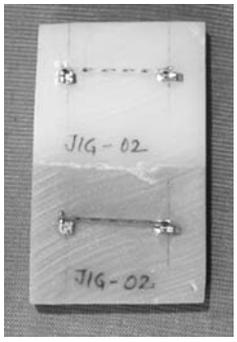

Fig. 2 : Acrylic jig

Fig. 3 : Force Gauge

A hand held force gauge (Yuyutsu Japan) with a minimum calibration of 5 gms to a maximum of 500 gms (Fig. 3) was used to measure the force values at T_0, T_1, T_2, T_3, T_4, T_5, T_6 and T_7 representing 0 (as received), 2 hrs, 12 hrs, 24 hrs, 3days, 5 days and 7days respectively. The initial force values at T_0 were recorded for each sample prior to being placed on the jigs.

The elastomeric chains were engaged without pre-stretching between the canine bracket and molar tube to exert force values of 450 gms. The jigs were immersed into petri dishes containing the test fluids for 2 hrs every day. The experimental setup was removed from the test fluid and rinsed under running water. Force values were recorded at the prescribed time periods ranging from T_1 to T_7. The jigs were stored in distilled water between thec immersion time periods. Each experiment protocol was repeated ten times.

RESULT

The data was recorded as per the protocol of the study at all time intervals. It was tabulated and subjected to two way ANOVA and t-Test. The force decay was calculated and compared at significance level of $p<0.01$ (Table I).

Table I: Mean force values for Cola based drink (in gms)

TIME INTERVAL	N	MEAN FORCE VALUE (in gms)
T_0- Sample 1	5	450
Sample 2	5	453
T_1- Sample 1	5	370
Sample 2	5	370
T_2- Sample 1	5	351
Sample 2	5	350
T_3- Sample 1	5	273
Sample 2	5	274
T_4- Sample 1	5	267
Sample 2	5	269
T_5- Sample 1	5	259
Sample 2	5	258
T_6- Sample 1	5	247
Sample 2	5	250

Table II: Mean force values for Lemon based drink (in gms)

TIME INTERVAL	N	MEAN FORCE VALUE (in gms)
T_0- Sample 1	5	450
Sample 2	5	450
T_1- Sample 1	5	361
Sample 2	5	366
T_2- Sample 1*	5*	320*
Sample 2*	5*	317*
T_3- Sample 1	5	251
Sample 2	5	259
T_4- Sample 1	5	250
Sample 2	5	252
T_5- Sample 1	5	244
Sample 2	5	228
T_6- Sample 1	5	238
Sample 2	5	220

**Statistically significant*

The maximum force decay of 29 % was found in the orange based drink which also had the highest acidic pH of 3. Force decay was statistically significant at T_1 i.e. 2 hours post immersion for all drinks compared (Table II). This decay was the highest for the elastomeric chains immersed in orange based drink followed by cola, lemon and the control. However there was no statistically significant difference between the force decay of the elastomeric chains immersed in aerated cola, lemon and the control (Table III & IV).

Table III: Mean force values for Lemon based drink (in gms)

TIME INTERVAL	N	MEAN FORCE VALUE (in gms)
T_0- Sample 1	5	452
Sample 2	5	451
T_1- Sample 1	5	391
Sample 2	5	358
T_2- Sample 1	5	324
Sample 2	5	336
T_3- Sample 1	5	297
Sample 2	5	284
T_4- Sample 1	5	252
Sample 2	5	252
T_5- Sample 1	5	241
Sample 2	5	244
T_6- Sample 1	5	233
Sample 2	5	239

Table IV: Mean force values for Control (in gms)

TIME INTERVAL	N	MEAN FORCE VALUE (in gms)
T_0- Sample 1	5	452
Sample 2	5	453
T_1- Sample 1	5	423
Sample 2	5	359
T_2- Sample 1	5	393
Sample 2	5	336
T_3- Sample 1	5	288
Sample 2	5	292
T_4- Sample 1	5	276
Sample 2	5	268
T_5- Sample 1	5	272
Sample 2	5	269
T_6- Sample 1	5	265
Sample 2	5	255

Though the elastomeric chains tested in the study were obtained from two separate manufacturers they showed a similar force decay pattern. There was no statistically significant difference between the force values recorded at all the time intervals ranging from T_0 toT_7 for both the samples.

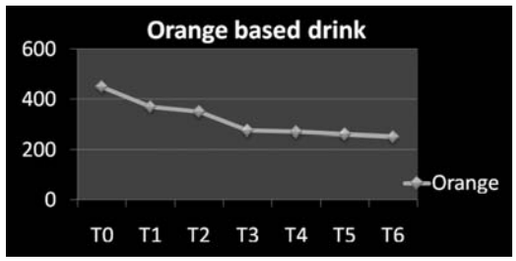

Fig 4 a : Marginal mean measure- ZIG 1

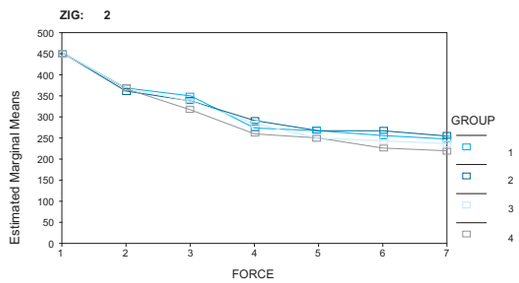

Fig 4 b : Marginal mean measure- ZIG 2

DISCUSSION

Polyurethane elastomers find a variety of uses in orthodontics as separators, elastomeric modules and elastomeric chains. The hydrophilic separators have a tendency for force decay with the absorption of saliva. This is an advantageous property as it helps in separation of teeth prior to placement of orthodontic bands.[7]

Elastomeric chains are used to close extraction spaces in orthodontics. Force decay is a factor associated with polyurethane E-chains. However the implication of this has clinical ramifications which may affect treatment outcomes differently to that expected. The clinician should be aware of the quantum and the rate of force decay along with the role of associated factors affecting this decay. This study was aimed to focus on the effects of commonly consumed aerated drinks on the force decay properties of elastomeric chains during orthodontic space closure *in vitro*.

Louis, Smith *et al*[2] evaluated the force decay of grey elastomeric ligatures and concluded that the greatest force loss occurred in the first 24 hours and that moisture and heat had a pronounced effect on force decay and permanent deformation. These findings were in agreement with that of the current study where the force decay percentage was highest at 24 hours for elastomeric chains immersed in aerated drinks and distilled water and the decay pattern was similar for both elastomeric chains tested.

The effect of pH on the force degradation rates of polyurethane elastics chain was evaluated by Ferriter *et al.*[3] They concluded that a significantly greater force decay rate occurred in basic solution with a pH of 7.6 as compared to that of the acidic pH of 4.95. However, the finding of this research are in contrast and indicate that a higher acidic pH (as in the orange based aerated drink) seemed to cause an enhanced rate of force decay, which was statistically significant at 2 hours post immersion. This decay was more pronounced in the orange based drink as compared to that seen with distilled water, cola and lemon based aerated drink. All of which had a less acidic pH compared to the orange drink.

Hershey and Reynolds[4] found a 50 % force loss after the first day, with 40 % of the original force remaining after 4 weeks. Similarly, in the present study, 40 % of the force decay occurred after 24 hours post immersion in both the test elastomeric chains in all the liquids tested.

Ash and Nikolai[5] concluded that there was no difference between force decay rates of clear and grey elastomeric chains *in vivo* and *in vitro*. Cassaus Danna[6] stated that there was no significant difference in the force decay between the different colored elastomeric chains tested. This is in agreement with the findings of the current study wherein no significant difference was seen in the force decay patterns of the clear and grey elastomeric chains.

Nattrass, Anthony and Martyn[7] evaluated the effect of three common environmental factors encountered namely- water, coke, and turmeric solution on elastomeric chain. The results indicated that there was no significant difference in the force decay values amongst the three test environments. In the current study, force decay rate of the elastomeric chains tested in cola based drink showed similar results to the lemon based drink and distilled water. However, the force decay rate was significantly different when compared to orange based drink at T1 (Fig. II).

Literature search has revealed no previous study where three commonly consumed aerated drinks with different flavoring agents has been tested on grey and clear elastomeric chain at eight different time intervals to assess the force decay rate. A detailed investigation of the manufacturers' official website reveals the cola based drink contains certain amounts of phosphoric acid while the lemon based drink had citric acid which may provide insights to the difference in pH.

The orange based drink contain flavoring agent dissolved in vegetable oil along with an emulsifying agent. The degrading effects of oil on cross linked polymers like polyurethane/latex products have been well documented in the pharmaceutical industry. Hence it may be inferred as a plausible explanation for the highest force decay rate of the elastomeric chain in the orange based drink could be due to the either or both the factors i.e. presence of vegetable oil and a high acidic pH.

CONCLUSION

- The current day orthodontic patients most often routinely consume moderate to large amounts of aerated drinks. Orthodontic space closure is commonly initiated with polyurethane elastomeric chains. Oral environmental factors like diet are likely to affect the force decay properties of these products.
- Aerated drinks have an acidic pH, which seems to have a similar force degradation pattern on both gray and clear elastomeric chains.
- The force decay was the highest at 24 hours post placement. This was statistically significant for the orange based aerated drink.
- The knowledge regarding effect of aerated drinks on elastomeric chains would help the clinician counsel the orthodontic patient regarding the quantity and quality of consumption of aerated drinks.
- From the current research where a limited variety of three drinks were studied, it could be recommended that the clinician advise the patient to avoid aerated drinks (especially the orange based) for a minimum period of two days post initiation of space closure with polyurethane elastomeric chains.

RECOMMENDATION

Further studies with larger sample size, spread over a longer duration with a variety of aerated drinks with different pH and compositions would throw light on the associated effects.

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