An Evaluation the Effect of Alcohol Presence in Mouth Washes on Force Degradation of Different Configurations of Elastomeric Chains

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ABSTRACT

Background: Elastomeric chains are one of the most commonly used force delivery systems. They have the ability to exert a continuous force, convenience of use, compatibility to oral environment and cost effectiveness but one of the inherited disadvantages is force degradation.

Materials and methods: This *in vitro* study was designed to evaluate the effect of alcohol presence in mouthwashes on force decay of different configurations of clear elastomeric chains from (Ortho Technology company) which are: closed , short and long under the effect of time at (Initial, 1, 2, 3 and 4 weeks) intervals with exposure to different chemical solutions. A total (540) modules of elastomeric chains of three different types (long, short and closed) transparent in color, with an initial length (19mm) and about 50% extension (29mm) were used for the study. These elastomeric chains divided in to four groups and exposed to different chemical solutions (Listerine Original alcoholic mouthwash, Listerine Zero alcohol mouth wash, Ethanol 26.9%, distilled water) twice daily for 60 seconds according to manufacturer instructions to measure the amount of force degradation in different time intervals. These elastomeric chains were incubated in covered glass containers at 37C˚ for the entire testing period.

Results: Statistical analysis showed that there was a highly significant difference in the mean percentage of force decay (P≤ 0.001). For all chemical solutions the highest percentage of force decay occurs in Listerine Original Alcoholic mouth wash. Also in all chemical solutions closed elastomeric chains has the least percentage of force decay. While closed configuration have the highest percentage of force decay.

Conclusion: We can conclude that alcoholic mouth wash(Listerine Original) causes increase force degradation of all types of elastomeric chains while alcohol free mouth wash (Listerine Zero) causes less force degradation of all types of elastomeric chains. Also closed configuration elastomeric chains have the least percentage of force decay than other configurations.

Key words: Evaluate the effect of alcohol presence in mouth washes on force degradation of different. (J Bagh Coll Dentistry 2016; 28(2):134-138).

INTRODUCTION

Use of an orthodontic appliance demands that the wearer take special care because the presence of this device in the oral cavity leads to greater accumulation of bacterial plaque around brackets and bands [1,2].

Considering that deficient oral hygiene generally is a reason why it is difficult to achieve successful orthodontic treatment, it is necessary for the dentist to implement an individualized model of a program of preventive education for each patient [3]. In individuals who cannot or are unable to perform good oral hygiene, in addition to mechanical control, it is important to implement chemical plaque control by using mouth washes [4].

Elastic chains are widely used in combination with fixed orthodontic appliances to close or to prevent the opening of spaces. Their main advantages include the following: ease of use, low price, reduced potential for intraoral trauma, minimal need for patient compliance, and wide array of colors or transparency.

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Their disadvantages can be seen in inconsistency of force levels over time, absorption of fluids leading to discoloration, and impairment of oral hygiene 3Various factors have been shown to impact the amount of force decay observed with elastomeric chains. One example of a controllable factor is the use of mouth rinses, which are commonly recommended to dental patients by orthodontists and other oral healthcare providers to assist in maintaining oral health during treatment. Many of these mouth rinses contain alcohol at various concentrations ranging from 0.5%–26.9%, with the majority around 14%. Ethanol is included in many mouth rinses as a dissolvent and carrier for the active ingredients. Is it possible that our recommendations may be contributing to the force decay of our materials and subsequently to less efficient orthodontic treatment? [5].

Therefore, the objectives of this study were twofold. First, to evaluate the effect of alcohol presence in mouthwashes on percentage force decay of elastomeric chain products, Second to evaluate the percentage force decay of three different configurations of elastomeric chain products from the same company.

MATERIALS AND METHODS

A prospective laboratory study was completed to evaluate the effect of alcohol presence in mouth washes on force degradation of elastomeric chain. A total (540) modules of elastic chains with different configurations (closed, short, long) transparent in color, having an expiry date at (2016), were selected from Ortho Technology Company, USA, were tested for load relaxation. The specimens used in the study having an initial length (19mm) and about 50% extension (29mm) and placed on custom made acrylic boards. These elastomeric chains divided in to four groups and exposed to different chemical solutions (Listerine

Original alcoholic mouthwash, Listerine Zero alcohol free mouth wash, Ethanol 26.9%, distilled water) twice daily for 60 seconds according to manufacturer instructions to measure the amount of force decay in different time intervals. These elastomeric chains were incubated in covered glass containers at 37C˚ for the entire testing period. All samples of elastomeric chains (except those tested for initial force) were placed under cyclic exposure between distilled water and chemical solutions during the test period of the study.

Six force measurements were made at the following time intervals: initial (0), one day, 1, 2, 3 and 4 weeks. Force measurements were obtained with a digital force tester. During force measurement, the acrylic boards were securely bound to a bench top using a vice clamp. Measurements were made by leaving one end of the elastomeric chain secured on the pin and fixing the other to the force tester (Fig.1), allowing for the measurement of the tensile force. Measurement readings were taken with the elastomeric chain stretched to the same 29 mm length that the acrylic board pins had previously maintained them. All chains were handled and measured in the same manner at the same vertical and horizontal distance on the acrylic board to ensure consistent measurements [5].

Figure 1: Force measurements of elastomeric chains used in the study

Statistical analysis

Data collected analyzed by using relevant soft ware statistical package of Social science (SPSS, Chicago, 111). These data of the delivered forces for all specimens were averaged, and the results were analyzed with the following statistics:

1. Descriptive statistics: mean of load, mean of the percentage of force decay and their standard deviation.
2. Inferential statistics: (ANOVA- test and LSD test).

RESULTS

Different configurations of elastomeric chains had different mean load and percentage of force decay over time (Tables 1, 2).

The statistical analysis indicated that there was a significant interaction between elastomeric chain configuration and chemical solution (P= 0.000); therefore, the effect of configurations on percentage force decay over time must be examined separately for each chemical solution over different time intervals (Table 3).

Table 1: Means and standard deviations of load values of different elastomeric chain types treated with different chemical solutions.

Duration	Elastics types	D.W. (I)		Listerine Zero (II)		Listerine Original (III)		Ethanol 26.9% (IV)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Initial N=30	Closed	365.018	0.03	365.018	0.03	365.018	0.03	365.018	0.03
	Short	341.027	0.03	341.027	0.03	341.027	0.03	341.027	0.03
	Long	315.016	0.02	315.016	0.02	315.016	0.02	315.016	0.02
1 day N=30	Closed	186.095	1.25	186.095	1.25	186.095	1.25	186.095	1.25
	Short	166.602	1.06	166.602	1.06	166.602	1.06	166.602	1.06
	Long	147.777	1.70	147.777	1.70	147.777	1.70	147.777	1.70
1 week N=120	Closed	181.262	1.18	180.021	0.99	173.708	0.53	176.76	0.72
	Short	159.356	1.09	158.816	1.58	155.421	0.93	157.82	1.55
	Long	140.371	1.19	138.583	0.99	137.612	0.84	139.78	0.83
2 weeks N=120	Closed	162.266	1.58	161.489	0.47	156.265	0.87	159.93	0.94
	Short	144.357	1.10	143.208	0.36	137.145	0.84	139.91	0.92
	Long	126.460	0.97	124.826	0.69	117.461	1.02	121.60	0.84
3 weeks N=120	Closed	155.056	1.10	153.420	0.72	149.606	0.98	149.74	1.03
	Short	135.837	0.86	132.761	0.86	129.524	0.50	129.89	1.05
	Long	117.882	0.86	115.177	1.04	110.549	0.97	111.53	1.71
4 weeks N=120	Closed	154.415	0.55	152.973	0.55	147.501	0.51	149.30	1.07
	Short	135.103	0.02	131.681	0.64	127.652	0.67	128.91	0.53
	Long	116.784	1.26	113.168	0.47	109.649	0.76	110.30	0.78

Table 2: Means and standard deviations of the percentage of force decay of different types of elastomeric chains immersed with different media

Duration	Elastics type	D.W. (I)		Listerine Zero (II)		Listerine Original (III)		Ethanol 26.9% (IV)	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Zero	Closed	0		0		0		0	
	Short	0		0		0		0	
	Long	0		0		0		0	
1 day N=30	Closed	49.017	0.34	49.017	0.34	49.017	0.34	49.017	0.34
	Short	51.147	0.31	51.147	0.31	51.147	0.31	51.147	0.31
	Long	53.089	0.54	53.089	0.54	53.089	0.54	53.089	0.54
1 week N=120	Closed	50.342	0.32	50.682	0.27	52.411	0.14	51.575	0.19
	Short	53.272	0.32	53.430	0.47	54.426	0.27	53.721	0.45
	Long	55.440	0.38	56.008	0.31	56.316	0.27	55.627	0.26
2 weeks N=120	Closed	55.546	0.43	55.759	0.13	57.190	0.24	56.187	0.25
	Short	57.670	0.32	58.007	0.10	59.785	0.25	58.974	0.27
	Long	59.856	0.31	60.375	0.22	62.713	0.32	61.399	0.27
3 weeks N=120	Closed	57.521	0.30	57.969	0.20	59.014	0.27	58.978	0.28
	Short	60.168	0.25	61.070	0.25	62.019	0.14	61.913	0.30
	Long	62.579	0.27	63.438	0.33	64.907	0.31	64.597	0.54
4 weeks N=120	Closed	57.697	0.15	58.092	0.15	59.591	0.14	59.099	0.29
	Short	60.384	0.004	61.387	0.19	62.568	0.19	62.200	0.16
	Long	62.928	0.40	64.076	0.15	65.193	0.24	64.986	0.25

Table 3: Effect of immersion time on force degradation of different types of elastomeric chains in different chemical testing solutions

Media	Elastics types	ANOVA test		LSD test									
		F-test	p-value	1 day-1 week	1 day-2 weeks	1 day-3 weeks	1 day-4 weeks	1week-2 weeks	1week-3 weeks	1week-4 weeks	2 weeks-3 weeks	2 weeks-4 weeks	3 weeks-4 weeks
D.W. (I)	Closed	1622.589	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.227
	Short	2391.620	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.080
	Long	1259.196	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.051
Listerine Zero (II)	Closed	3331.326	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.241
	Short	2488.377	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.019
	Long	1997.562	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Listerine Original (III)	Closed	3710.628	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Short	4354.968	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Long	2408.264	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.075
Ethanol 26.9% (IV)	Closed	2677.508	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.331
	Short	2523.051	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.046
	Long	1829.292	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.033

DISCUSSION

Effect of Different configurations

Examination of table (2) reveals that closed elastomeric chains has the least percentage of force decay in all chemical solutions and all time intervals followed by short elastomeric chains and the highest percentage of force decay occur in long configurations in all chemical solutions. Difference in the degree of the initial mean loads was noted among the studied brands (Table 1).

Regarding the modular geometry or design, the trend which was presented that elastomeric chains with short and long configuration had initial mean load which is less than closed configuration. This might be explained by the increased concentration of the load with the longer segment since number of the load carrying chains 'units or rings reduced as the link extension length was increased [6].

Consequently, further disruption of the molecular arrangement and more breaking of the intermolecular bonds being more with the long module than the short one. This in contrast to the closed elastomeric products, where the strain developed at the modular rings was much higher its degree in the open design so the higher number of rings closely packed to be as one unit (stiff body) possesses a higher strength [7-9].

Effect of chemical solutions

The highly significant difference between the results of the samples that have been tested in distal water and different types of mouthwashes that has been used during this study; may be related to some factor or factors that are able to modify the physical properties of elastomers, such as the pH level, stretching, wet condition, thickness of elastic, temperature, time.

Ethanol is included in many types of mouth washes and at different concentrations range from (0.5-26.9%). It works as a dissolvent and carrier for active ingredients. Listerine Original mouthwash and Ethanol 26.9% causes the highest level of force decay of elastomeric chains of all configurations, because when ethanol is analyzed microscopically emersion of polyurethane elastomeric modulus with 75% ethanol/water mixture causes molecular and structural modification leading to decay of elastomeric chains, Listerine Zero mouth wash have higher force values than ethanol or Listerine Original mouth wash for all types of elastomeric chains and whole testing period. So alcohol causes increase in force decay of elastomeric chains over time [5,10]. Although Listerine Zero contain sodium fluoride (Naf 0.02%), it does not cause a significant increase in force degradation of elastomeric chain [11].

At all the times, distilled water specimens exhibited higher force values than those in any other chemical solutions in the present study because these solutions contain components which facilitate migration by penetrating the polymer or increasing migrant solubility compared to the pure water [12].

The present study suggests that alcoholic mouth wash (Listerine Original) causes increase force degradation of all types of elastomeric chains while alcohol free mouth wash (Listerine Zero) causes less force degradation of all types of elastomeric chains. Also closed configuration elastomeric chains have the least percentage of force decay than other configurations.

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