

Effect of Three Types of Mouth Washes on the Force Decay of Elastomeric Chains (An *in Vitro* Study)

Reem A. Rafeeq¹, Sara M. Al-Mashhadany², Hiba M. Hussien³, Dheaa H. Al-Groosh⁴

^{1, 2, 3, 4} University of Baghdad, College of Dentistry, Department of Orthodontics, Baghdad, Iraq

Abstract: This study designed to evaluate the amount of force decay of elastomeric chains (power chain) when exposed to mouth washes with 3 different ingredient agents of the same brand. The sample was divided into four groups; each containing 40 pieces of closed type of elastomeric chain with a total 160 pieces. The force measurements were obtained with a digital force gauge. Descriptive statistics was obtained for the tested groups and the force decay and their variation among the tested groups during different immersion time were analyzed using ANOVA and tukey tests. The study showed highly significant increase of the force decay of elastomeric chains for all the groups in all immersion times regardless the test solutions. The highest measurement were detected in the first 24 hours. Additionally, the chlorhexidine containing mouth wash group showed the highest force decay among the groups where the resultant force detected below the clinically recommended value. In conclusion, the orthodontist should considered that the loss of force of power chain is inevitable and prescribing chlorhexidine containing mouth wash should be considered with special consideration to shortening the periodic follow up visits.

Keywords: Elastomeric chain, Force decay, Mouth washes, Biofresh.

1. Introduction

Elastomeric chains and other elastics are widely used in orthodontics as an active component. Elastics have been an appreciated aid to many types of orthodontic movement for years. If this is associated with good patient compliance the clinician will be able to correct both antero-posterior and vertical inconsistencies⁽¹⁾. When the elastomeric chains are activated they will be permanently stretched, thus reducing the force apply on the teeth⁽²⁾.

Most of studies regarding the force degradation of the elastomeric chain have been performed *in vitro*; this may be advantageous to delimit the cofactors that corresponding to the clinical *in vitro* studies which may add an impact on the results, such as chemical components from saliva, food beverages, oral hygiene products, thermal agitation, and mechanical factors due to the chewing and oral hygiene procedures. These factors may alter the properties of elastomeric components in such a way that cannot be simulated *in vitro* tests⁽³⁾. Efforts to simulate the oral environment have involved testing in experimental test solutions included distilled water, artificial saliva, natural saliva and fluoride solutions. However, there are clear differences in the features and effects of the 'real life' and simulated environments i.e. *in vivo* and *in vitro*^(3, 4).

Orthodontic treatment with fixed braces may compromise the oral hygiene as these attachments are considered as plaque retentive factors. In noncompliance patients, adjunctive oral hygiene measures may be recommended to overcome the shortcoming of improper brushing technique i.e. gingivitis and white spot lesions. Of these measures, topical fluoride application, mouth washes with different active ingredients and varnishes was used⁽⁵⁾. It was proposed that when acidulated phosphate fluoride used, the amount of force delivery and the decay rate was 31% of the elastomeric chains⁽⁶⁾. Similarly, it was claimed that load-relaxation of the

elastomeric chain was significantly increase when there was a sustained exposure to fluoride media⁽⁷⁾.

On the other hand, alcohol containing mouth washes had a highly significant effect on the amount of force load and force decay of elastomeric chains especially in the opened type chains. Whereas the alcohol free mouth wash had low effect on the amount of force degradation⁽⁸⁾.

The current study was designed to assess the effects of three types of mouth washes, containing different active ingredients such as fluoride, permethol and alcohol and chlorhexidine, of the same brand which are widely used in orthodontic practice on the amount of force and force decay at different time intervals.

2. Materials and Method

An *in Vitro* study was designed to investigate the effect of the exposure of orthodontic elastomeric chains to mouthwashes with 3 different active ingredient. The sample was divided into four groups of 40 piece of elastics (Morelli, Sorocaba, Brazil) each which counts for a total of 160 piece. The elastics were of closed type and were cut into a standard length of 19 mm⁽⁷⁾.

The samples were mounted onto four purposely made acrylic platform, each contains 80 circular pins arranged into two parallel rows with a distance of 29mm (Figure 1). The pins in each row were separated by a distance of 0.5cm arranged and the elastic were attached and stretched to between the antagonizing pins⁽⁷⁾. These templates allowed the elastomeric chains to be fully submerged in the test solutions. The test groups were exposed to the test solutions, for 60 seconds twice daily; Force measurements were obtained at four time intervals (initial, 1, 7, and 21 days).

The samples exposed to the testing solutions as followed: The distilled water (control group); group 1: Biofresh F sodium fluoride 0.025% mouthwash; group 2: BiofreshP permethol and provit B5 mouthwash and group 3: BiofreshK fight gingivitis 0.12% chlorhexidine (all Biofresh, Dubai, UAE).

The test groups were independently immersed in distilled water at 37°C and kept in an incubator (Mettler, Schwabach, Germany). The temperature was monitored using a digital thermometer. The samples were immersed in the test samples as allocated for 1 minute then washed with distilled water to simulate salivary rinsing effect in the oral cavity. After that, the samples were returned to the incubator (Mettler). The force measurements were obtained with a three digit digital force gauge (Weiheng, Japan).

After each measurement, the force gauge was reset before taking the next measurement. Measurements were done by securing one end of the elastomeric chain on the pin and fixing the other to the force gauge where the elastics were stretched to 29 mm to maintain the same length as that of the acrylic template.

Values of percentage of force decay at each time interval of follow up period were calculated as a mean percentage of force decay compared to the baseline measurement i.e. the percentage of the initial force calculated using the following equation:

$$\% \text{ FD} = 100 \times [(IF - Ft) / IF]$$

Where the FD=force decay, IF=the initial force and Ft=the force at specific time^(9, 10).

Statistical analysis

Data were analyzed using the software statistical package of social science (SPSS version 17). The means of percentage of force decayed were analyzed using ANOVA test to compare between the test groups and the effect of immersion time within each group. Tukey HSD was used to find out the differences in force decayed. The P-value was set at <0.05 and $\alpha = 0.05$

3. Results

Table 1 and **Figure 1** describes the force value of the elastomeric power chain immersed in different test solutions at different time interval. The highest force value were measured in the baseline time lapse and decreased gradually after successive immersion in all media. The lowest force value was detected in chlorhexidine mouth wash group (Biofresh K), followed by permethol and alcohol group (Biofresh P), NaF group (Biofresh F) and distilled water group (139.06g, 160.47g, 150.43g, 168.57g) respectively.

Table 2 shows the comparison between the force decay of elastomeric chains among the four test groups at each time interval. The Biofresh K (chlorhexidine) group showed the highest force decay among the tested groups ($p < 0.001$) in all measurements at each time interval, while the control group showed the lowest value followed by the Biofresh F (NaF) group. This was reflected at all tested solutions in which there were highly significant differences among them (Table 3)

Table 4 reveals the effect of immersion time on the force decay of the elastic power chain in different solutions. The data showed that the longer the immersion time the higher the amount of force decay among all groups and that there were highly significant differences among each successive immersion time.

4. Discussion

Many studies were conducted to assess the effects of various factors, such as time, temperature and pH, on the force magnitude of elastomeric chain^(1,2,3).

Time represented the most important factor that affected the force degradation of elastomeric chains. Several research conducted on orthodontic polyurethane elastics were reported that the force of polyurethane elastics decayed over time and that the amount of force decay increased due to the effect of hydrolysis. They demonstrated that most of the force loss occurred within the first 24 hours and much less occurred over the remaining 3 weeks^(11, 12, 13).

The current data showed that the force decay exhibited a sudden drop, with the majority of force loss occurred within the first day (43.2%-49.4%), followed by a steady loss of force over the first and the third week. This was probably related to the differences in the viscosity of the elastic material providing different force/relaxation ratios when subjected to different chemical environment. This come in accordance with^(7,8,9)

Regarding the effect of mouth wash on force decay, it has been suggested that load relaxation was statistically significant when there was a prolonged exposure to different immersion media, This could be attributed to load relaxation pattern, which is correlated to the variances in the viscosity of the elastic material presenting various force /relaxation ratios by consumption of the chemical environment⁽¹⁴⁾. Immersion of elastomers in aqueous solution cause force relaxation action which intern had a negative effect on the mechanical properties⁽⁷⁾. It was claimed that daily use of NaF mouth rinse have lower effect on force degradation and displacement of elastomeric chains compared to other mouth rinses which come in accordance with the current study, however, with higher force levels, the displacement increased significantly⁽¹⁵⁾. On the other hand, Von Frounhofer *et al*⁽¹⁶⁾ stated that the exposure of elastic chains to topical fluoride affected the elastic properties and increase the deterioration effect of these chains.

Regarding Biofresh P which contain alcohol, it was found that alcoholic containing mouth wash, such as Listerine Original, caused an increase in force decay of different types of elastomeric chains unlike the alcohol free mouth wash Listerine Zero which caused a lesser force degradation on different types of elastomeric chains⁽⁸⁾.

Regarding BiofreshK which contains Chlorhexidine, it was concluded that the force decay increase with the use of such a mouth wash due to the fact that these media include constituents which simplifies migration by infiltrating the polymer in comparison with the distilled water⁽¹⁷⁾. This

probably due to the plasticizing effect of chlorhexidine on these materials⁽¹⁸⁾.

This research conducted to assess and compare the effect of three immersion solutions (which are most frequently used during orthodontic treatment as a chemical plaque control and gingival health measures) on force decay of elastomeric Chains with different immersion time. The data revealed that the use of Biofresh K (Chlorhexidine ingredient) mouth wash showed the highest force decay followed by biofresh P (permethol and alcohol) mouth wash, whereas Biofresh F (NaF) mouth wash showed the least force degradation. Moreover, the longer the immersion time the higher the amount of force degradation regardless the test solution. This agreed with the results of many previous studies^(7,11-15,17). Having said that, the amount of force exerted by the elastomeric chain didn't have a clinical relevance, since the resultant forces were above the clinically recommended forces i.e. 150 g apart from chlorhexidine containing mouth wash.

5. Conclusions

The elastomeric chains are greatly affected by the immersion solutions and the time of immersion regardless of the active ingredient of the mouth wash. Moreover, the use of mouth wash should be prescribed with cautious to weigh the benefits vs the disadvantaged of each ingredient per se. it is wise to use chlorhexidine containing mouth wash, however, it may need shorter follow up visits to change the elastomeric chain.

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Table 1: The mean force values and Standard deviation (in g) of the elastomeric power chains immersed in different chemical solutions

Immersion solution	Duration	Mean	S.D.	Minimum	Maximum
Distilled water	initial	354.46	0.84	352.9	355.4
	1 day	201.12	0.84	199.5	202.3
	1 week	181.09	0.85	179.7	182.3
	3 weeks	168.57	0.84	166.7	169.6
Biofresh P	initial	354.5	0.92	352.7	355.7
	1 day	183.9	1.24	180.9	184.8
	1 week	172.41	0.91	170.9	173.8
	3 weeks	150.43	1.16	148.4	152.2
Biofresh F	initial	354.92	0.45	353.9	355.4
	1 day	191.14	0.87	189.8	192.1
	1 week	179.24	0.52	178.6	180.2
	3 weeks	160.47	0.68	159.6	161.5
Biofresh K	initial	354.84	1.14	352.6	355.9
	1 day	179.54	0.75	178.5	180.8
	1 week	162.43	0.66	161.6	163.4
	3 weeks	139.06	0.69	137.7	139.7

Table 2: Comparison between the force decay for the elastomeric chain immersed in different test solutions.

duration	Immersion solution	Mean	S.D.	ANOVA test	
				F value	P
1 day	D.W	43.2	0.27	881.9	.000
	Biofresh P	48.12	0.35		
	Biofresh F	46.14	0.22		
	Biofresh K	49.4	0.27		
1 week	D.W	48.91	0.27	909.2	.000
	Biofresh P	51.36	0.28		
	Biofresh F	49.49	0.19		
	Biofresh K	54.22	0.23		
3 weeks	D.W	52.44	0.31	1535.3	.000
	Biofresh P	57.56	0.36		
	Biofresh F	54.78	0.2		
	Biofresh K	60.81	0.24		

Table 3: Tukey HSD test for the effect of each two different test solutions on force decay of elastomeric power chain.

Duration	D.W-Biofresh P		D.W-Biofresh F		D.W-Biofresh K		Biofresh P-Biofresh F		Biofresh P-Biofresh K		Biofresh F-Biofresh K	
	mean diff.	sig.	mean diff.	sig.	mean diff.	sig.	mean diff.	sig.	mean diff.	sig.	mean diff.	sig.
1 day	-4.86	.000	-2.8	.000	-6.14	.000	1.9	.000	-1.27	.000	-3.25	.000
1 week	-2.4	.000	-0.58	.000	-5.31	.000	1.8	.000	-2.85	.000	-4.72	.000
3 weeks	-5.12	.000	-2.34	.000	-8.36	.000	2.77	.000	-3.24	.000	-6.02	.000

Table 4: Effect of immersion time on force decay of elastomeric chain in different test solutions.

Immersion solution	Immersion time	F test	P value	Tukey HSD					
				1 day-1 week		1 day-3 week		1 week-3 week	
				Mean difference	sig	Mean difference	sig	Mean difference	sig
distilled water	1 day	2584.2	.000	-5.65	.000	-9.18	.000	-3.5	.000
	1 week								
	3 weeks								
Biofresh P	1 day	2012.4	.000	-3.24	.000	-9.81	.000	-6.2	.000
	1 week								
	3 weeks								
Biofresh F	1 day	4339.9	.000	-3.35	.000	-8.64	.000	-5.28	.000
	1 week								
	3 weeks								
Biofresh K	1 day	5123.3	.000	-4.82	.000	-11.4	.000	-6.5	.000
	1 week								
	3 weeks								

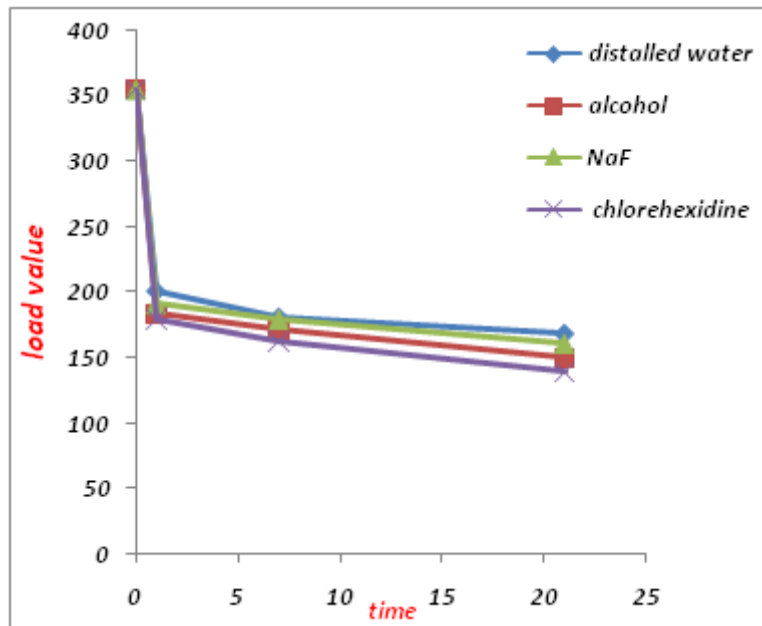
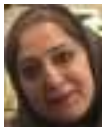


Figure 1: Mean load value of the elastomeric power chain immersed in different chemical solution

Author Profile



Reem A. Rafeeq received the B.D.S. and M.Sc. in Orthodontics from the College of Dentistry, University of Baghdad in 1998 and 2003 respectively. In 2001, she joined the higher studies to get the M.Sc. degree in 2003. Now, she is an assistant professor in the department of Orthodontics, College of Dentistry /University of Baghdad.



Sara M. Al-Mashhadany received the B.D.S. and M.Sc. degrees in Orthodontics from the College of Dentistry, University of Baghdad in 2004 and 2009, respectively. During 2004-2007, she was a resident in the same college. In 2007, she joined the higher studies to get the M.Sc. degree in 2009. Now, she is a lecturer in the department of Orthodontics, College of Dentistry/ University of Baghdad.



Hiba M.H. Al-Chalabi received the B.D.S. and M.Sc. degrees in Orthodontics from the College of Dentistry, University of Baghdad in 2004 and 2009, respectively. During 2004-2007, she was a resident in the same college. In 2007, she joined the higher studies to get the M.Sc. degree in 2009. Now, she is a lecturer in the department of Orthodontics, College of Dentistry/ University of Baghdad.



Dheaa H. Al-Groosh received the B.D.S. and M.Sc. in Orthodontics from the College of Dentistry, University of Baghdad in 1996 and 2000 respectively. In 2014, he received the PhD degree in orthodontics from UCL/ Eastman Dental Institute/UK.. Now, he is an assistant professor in the department of Orthodontics, College of Dentistry /University of Baghdad.