Comparison of most popular mouthwashes in Iraqi population on force degradation of elastomeric chain

By

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Abstract

Aim of the study: the current study aims to compare and contrast the force degradation of two distinct elastomeric chains after varying exposure times to popular mouthwashes in Iraq.**Materials and Methods**: Two control groups and six experimental groups each included 600 pieces of the elastomeric chains Elasto-Force and Super Elasto-Force. Pieces were stretched to a 25mm thickness, placed on pins set into an acrylic block, and kept at 37°C in artificial saliva. Throughout the testing time, the experimental groups were submerged in three different types of mouthwash for one minute each. Ten continuous thermocyclers (5-55°C) per day were conducted between cold and hot water baths. Six-time periods (beginning, 24 hours, 1, 2, 4, and 6 weeks) were used to measure the forces. In order to compare the mean force between various elastomeric chains, mouthwashes, and times, the one-way ANOVA test and the t-test. The significance threshold was set at 0.05. **Results**: Over time, both types of elastomeric chains significantly lost force (71–75% at 6 weeks). At all times, the Super Elasto-Force created more force than the Elasto-Force elastomeric chain. Compared to other mouthwashes, chlorhexidine mouthwash had a substantially less impact on force degradation, with no discernible change when compared to control groups. **Conclusions**: The Super Elasto-Force provided a greater force level, according to these data, and there is a clinically significant difference between the two kinds of elastomeric chains. Instead of other chemicals, the mouthwashes' pH may contribute to force breakdown over time. Following Listerine (Total Care Zero) and Orthokin, mouthwashes containing chlorhexidine and chlorhexidine had the least impact on the force degradation of elastomeric chains, respectively.

Keywords: mouthwashes; force degradation; elastomeric chain ; Iraqi population

Introduction

Elastomeric chains have been used often in orthodontics since the 1960s, and their effects have been researched ever since (1-3). They have been utilised to accomplish a number of goals, including sealing extraction spaces, midline correction, repositioning impacted teeth, and generalised space closure (2). They are frequently utilised because they are affordable, practical, easy to use, and don't require patient participation (1). When the chains are stretched and exposed to the oral environment, they may become wet and lose their internal connections, resulting in an irreparable malformation (3). Stress relaxation results in a specific rapid loss of force and a progressive loss of efficacy for each kind of elastomeric chain (4). The first twenty-four hours following the application of an elastomeric chain showed a significant amount of force degradation (13–75%) in several experiments(4,5).

This fluctuation range depends on a variety of variables, such as the environment, the assessment time, the evaluation method, the pre-stretching, and the initial force applied (5-7). There are some unresolved questions regarding the initial force required for success as well as how long the residual force may continue to be considered therapeutically beneficial. Most studies have either been conducted in vivo or in vitro (4,8,9). Stretching produced a considerable reduction in each study. The first twenty-four hours following the application of an elastomeric chain show a significant degree of force loss (13 to 75%), according to several studies (10,11).

Orthokin mouthwash is frequently advised by orthodontists. Because it contains zinc acetate, chlorhexidine digluconate, and sodium fluoride (12), Orthokin mouthwash can reportedly be used to fight bacteria and prevent cavities (13).However, it's critical to highlight LISTERINElonger-term ®'s (3-6 months) effectiveness in supporting gingival health above that of shorter-term (3 months). Thus, the use of EO-containing mouthwash (LISTERINE®) to improve oral health was thoroughly investigated in the literature at the time.

This fluctuation range is influenced by a number of variables, including the environment, pre-stretching, the length of the assessment, the evaluation method, and the composition and size of the elastomeric chain (14). There are some unresolved questions regarding the initial force required for success as well as how long the residual force may continue to be considered therapeutically beneficial. The optimum environment to study the behaviour of the elastomeric chains now in use under stress appears to be in vivo testing. However, the sample size required to discover differences between different elastomeric chain types is greatly increased by the challenges in standardising the distance or initial force during retraction as well as the substantial individual variances in responses to orthodontic pressures (15). A degree of system simplification is possible thanks to an in vitro evaluation, which enables the researcher to focus on a small number of components and rule out certain elements. Even while in vitro research has its advantages, the oral cavity cannot be precisely simulated in a laboratory setting. Therefore, an in-situ assessment combines the homogeneity of in vitro testing with the in vivo environment.

Material and Methods

In this investigation, two short, transparent elastomeric chains from Dentaurum in Ispringen, Germany, Super Elasto-Force (SEF) and Elasto-Force (EF), were used.

Listerine Total Care Zero® (a fluoride-containing mouthwash), Orthokin®, and chlorhexidine® were the mouthwashes employed.In total, 600 pieces were used, equally divided between EF and SEF.

A control group in which the elastomeric chain was submerged in artificial saliva served as well as three test groups, one for each type of mouthwash, were created for each type of elastomeric chain. either elastomeric chain link has five loops, with an additional half loop at either end to guard against any damage during handling (1). Using a digital pH meter (GOnDO, PL-700PC, Taipei/Taiwan), the pH of each mouthwash and the artificial saliva was determined. The results are displayed in Table 1.

Ten acrylic blocks with twenty stainless-steel pins were used to stretch the elastomeric parts into place.To reflect the spacing between the canine and first molar teeth, the 20 pins were set in two parallel rows, 25mm apart (16). The residual forces of the 600 pieces' mountings were measured using a digital force gauge at six different time intervals (time 0 under dry conditions, 1 day, and(1 ; 2 ; 4 ; 6)weeks (Weiheng, China).

The acrylic block was firmly clamped to a workbench throughout the force measurement. To measure the tensile force, one end of the elastic chain was attached to the force tester, and the other end was pin-secured.Twenty pieces, ten of each kind, were measured for the force at two different time points: initially (in dry condition) and one day later (only kept in artificial saliva). As mouthwash exposures start soon after the 1-day time point force test, 100 pieces were then assessed for the residual force at each time point. All samples of elastomeric chains were kept in plastic containers filled with fake saliva and incubated at 37°C for the length of the test (except for those evaluated for initial force).

Table 1: chemical solution pH

Chemical	pH
Artificial saliva	7.1
Chlorhexidine	7.47
Listerine	4.47
Orthokin	4.54

All samples were run through ten continuous thermocyclers each day after the force measurement on day one, switching between (cold 5°C and hot 55°C))water baths with dwell periods of 30 seconds in each and exchange times of 30 seconds (1). This was carried out to mimic changes in oral temperature. The experimental samples were extracted from synthetic saliva every 12 hours, and they were then immersed for one minute in the appropriate mouthwash mixture. From day 2 until the end of the research, this procedure was carried out daily, with mouthwashes being replaced as necessary.

To replicate the patient using the mouthwash, they were transferred to a different distilled water container designed specifically for each mouthwash after immersion (17). They were ultimately rinsed with water, put back in the main container, and incubated at 37°C. The technique for the control samples was the same as for the experimental samples, except they were subjected to artificial saliva rather than mouthwash.

Statistical Analysis

SPSS version 26, Microsoft Excel 2010, Using normality tests, we determined whether the study's data was parametric or non-parametric. Statistical tests were thus used. Oneway ANOVA and T-test independent evaluated differences.

Results

The Shapiro-Wilk test results demonstrated that the data were regularly distributed. Two different kinds of short, transparent elastomeric chains were immersed in each chemical solution for variable lengths of time, and the average and standard deviation (SD) of the force values are shown in Table 2.

The effects of time were statistically significant across all groups and at all points in time (Figure 1).the different elastomeric chain types were compared using an independent sample t-test. For all kinds of elastomeric chains as well as at all-time points, the impact of various chemical solutions was statistically significant (Table 3).

Table 2: Loss of force generated by elastomeric chains treated with different chemical solutions, such as Super Elasto-Force and Elasto-Force.

The Duration	Elastic type	Artificial saliva	Chlorhexidine	Listerine	Orthokin	P .value
		Mean±SD (gm)				
Initial	Elasto-force (EF)	345.50±5.828	350.20±1.852	350.20±1.852	350.20 ±1.852	<0.001
	Super Elasto-Force (SEF)	374.82±3.821	374.82±3.821	374.82±3.821	374.82 ±3.821	
1 day	Elasto-force (EF)	190.26±3.306	190.26±3.306	190.26±3.306	190.26±3.306	<0.001
	Super Elasto-Force (SEF)	213.38±5.938	213.38±5.938	213.38±5.938	213.38±5.938	
1 week	Elasto-force (EF)	152.42±1.98	146.08±3.579	148.66±2.134	148.74±2.239	<0.001
	Super Elasto-Force (SEF)	163.78±2.85	154.44±2.757	154.38±2.769	154.16±2.944	
2 week	Elasto-force (EF)	142.26±1.575	141.26±1.575	140.64±1.549	139.64±1.549	<0.001
	Super Elasto-Force (SEF)	147.62±1.08	146.62±1.028	145.62±1.08	144.62±1.028	
4 week	Elasto-force (EF)	131.76 ±1.42	130.76±1.492	129.76±1.492	127.76±1.492	<0.001
	Super Elasto-Force (SEF)	137.52±1.555	136.52±1.555	136.52±1.555	134.52 ±1.555	
6 week	Elasto-force (EF)	122.24±1.779	121.24 ±1.779	120.24±1.779	119.24±1.779	<0.001
	Super Elasto-Force (SEF)	127.18±1.273	126.18±1.273	125.18±1.273	124.18±1.273	

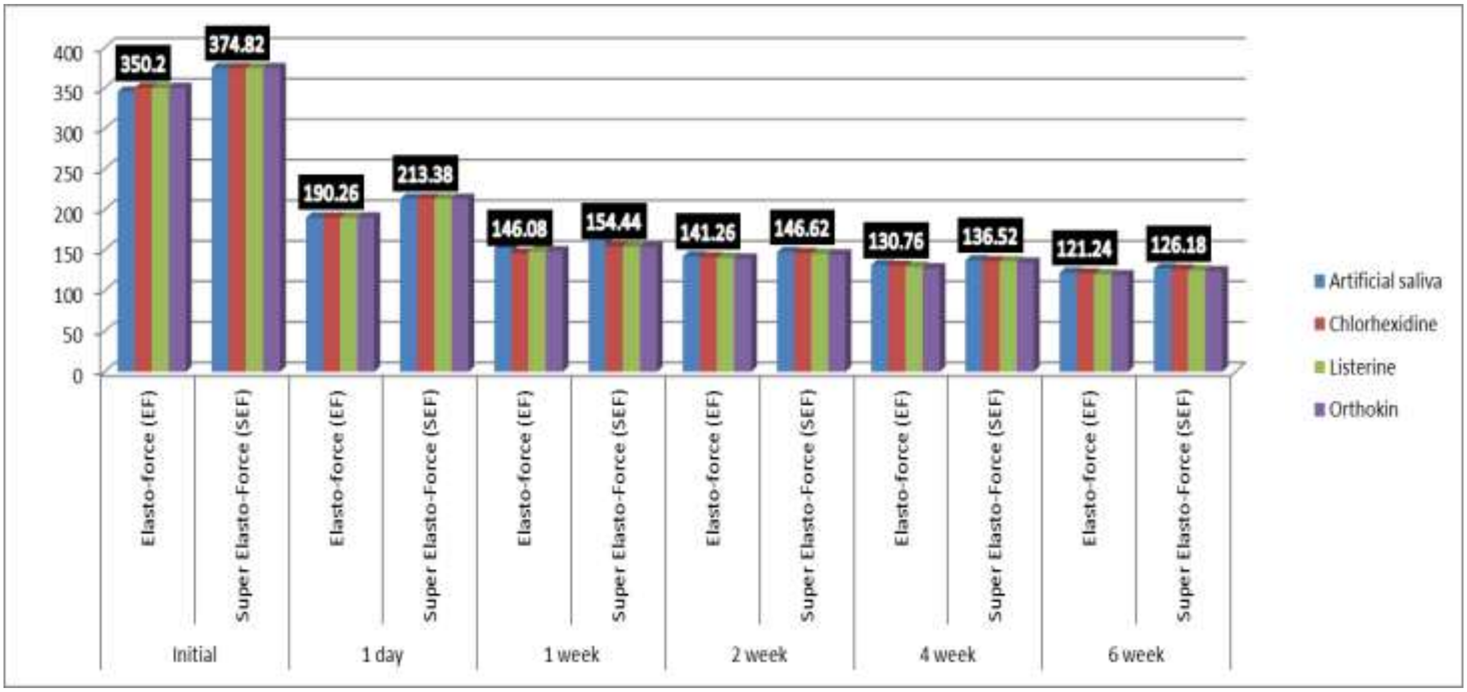

Figure 1: Force degradation of Super Elasto-Force and Elasto-Force elastomeric chains subjected to various chemical treatments.

Table 3: Comparison of the elastic chains' Super-Elasto-Force and Elasto-Force forces.

Media	Time	Elasto-force (EF)	Super Elasto-Force	Comparison		
		(M.±SD)		Mean difference	t-test	P. value
Artificial saliva	1 day	190.26±3.306	213.38±5.938	-23.120	-24.054	<0.001
	1 week	152.42±1.98	163.78±2.85	-11.360	-23.413	<0.001
	2 week	142.26±1.575	147.62±1.08	-5.360	-20.148	<0.001
	4 week	131.76±1.42	137.52±1.555	-5.760	-18.898	<0.001
	6 week	122.24±1.779	127.18±1.273	-4.940	-15.968	<0.001
Chlorhexidine	1 day	190.26±3.306	213.38±5.938	-23.120	-24.054	<0.001
	1 week	146.08±3.579	154.44±2.757	-8.360	-13.085	<0.001
	2 week	141.26±1.575	146.62±1.028	-5.360	-20.148	<0.001
	4 week	130.76±1.492	136.52±1.555	-5.760	-18.898	<0.001
	6 week	121.24±1.779	126.18±1.273	-4.940	-15.968	<0.001
Listerine	1 day	190.26±3.306	213.38±5.938	-23.120	-24.054	<0.001
	1 week	148.66±2.134	154.38±2.769	-5.720	-11.568	<0.001
	2 week	140.64±1.549	145.62±1.08	-4.980	-18.945	<0.001
	4 week	129.76±1.492	136.52±1.555	-6.760	-22.179	<0.001
	6 week	120.24±1.779	125.18±1.273	-4.940	-15.968	<0.001
Orthokin	1 day	190.26±3.306	213.38±5.938	-23.120	-24.054	<0.001
	1 week	148.74±2.239	154.16±2.944	-5.420	-10.362	<0.001
	2 week	139.64±1.549	144.62±1.028	-4.980	-18.945	<0.001
	4 week	127.76±1.492	134.52±1.555	-6.760	-22.179	<0.001
	6 week	119.24±1.779	124.18±1.273	-4.940	-15.968	<0.001

Discussion

Artificial saliva was utilised as the control group because studies have indicated that forces degrade more quickly in moist environments than in dry ones (18–20). The chains used in this study were thermocycler because temperature fluctuations have a substantial impact on how orthodontic chains behave (21). Since the canine's distal migration normally requires 200 g of force, that was chosen as the starting force (22,23).

In an effort to reduce the impact of other confounding factors such as pH, damp environments, stretching, temperature, and mastication, this investigation was conducted in vitro. Six-time periods (initial, one day, one week, two weeks, four weeks, and six weeks) were used to test the elastomeric chains in order to track changes that develop over time between adjustment sessions and compare the outcomes of previous research (22,24-26). According to Proffit *et al.,* (27), who thought it was a more usual appointment cycle, the 4 and 6-week time periods were likewise selected as an endpoint. Unlike chlorhexidine mouthwashes, which should not be used for more than two weeks in a row to prevent their negative effects, all of the tested mouthwashes are available over the counter and the manufacturer lays no limitations on their use term (28).

The initial force values ranged from (345.505.828 to 374.823.821) gm, indicating that both types of chains produced forces greater than the 300 gm limit that has been suggested by Quinn and Yoshikawa (22) and Lotzof et al. as a clinically acceptable threshold for the movement of a group of teeth or a single tooth (24). The working weights of the Elasto-Force and Super Elasto-Force elastomeric chains after 24 hours were approximately 182.5 gm (51.41% residual force) and 199 gm (53.49% residual force), respectively. These weights are regarded as medically suitable (22, 24).

According to Baty *et al.,* these observed force decreases within the first 24 hours fall between 50 and 80 percent of the residual force values (25). After three weeks of activation, the elastomeric chains' average residual force was 32–37%, While De Genova et al. (30) showed a slightly wider range of 39.1 to 56%, Aldrees et al. (29) observed a drop of 45%. Grassi et al. (26) discovered a reduction of between 20 and 40%.

By the conclusion of the third week of activation, Oshagh and Ajami (31) discovered a much lower proportion of force remaining at 15.84%. The lowest limit of force level for medically tolerable tooth movement, according to Baty *et al.,* (25) was 100 gm. Only control groups and chains treated with chlorhexidine mouthwash had a mean load that was equivalent to or greater than this value at the 4-week mark, and by the 6-week mark, all groups had fallen below this advised force threshold.

In fact, two important mechanisms that could account for the elastomeric chain's force degradation pattern over time are fluid absorption and the stretching mechanism of the chain. The molecular polymer that is contained within a chain under stress is the source of chain slippage, polymer molecules slipping past one another, broken primary bonds, and the appearance of permanent deformation. After the stretching mechanism, the fluid's absorption, which has a plasticizing impact, is what affects the force degradation pattern. The amount of delivered force varied between two types of elastomeric chains. Super Elasto-Force elastomeric chain type consistently delivered higher force than Elasto-Force type.

Even while the distance between the lumen of the loops in both Super Elasto-Force and Elasto-Force elastomeric chains is the same, it appears that this difference is caused by the larger loops and links in Super Elasto-Force chains. The results of this examination differ from those of Aldrees et al.'s (29) 2-week study on the color stability and force degradation of 19 distinct transparent elastomeric chains. By comparison to the Elasto-Force type, the Super Elasto-Force chain consistently demonstrated lower mean load and force degradation, according to their investigation.

The variations might be related to methodological inconsistencies, varying beginning forces, ambient factors, and varied force-measuring devices. The findings of the current investigation demonstrated that both chain types exposed to mouthwashes had lower levels of force than chains exposed to pure water alone. Additionally, the chlorhexidine-treated groups consistently displayed statistically significant changes from the control groups. Other researchers have previously assessed how mouthwashes containing sodium fluoride and chlorhexidine affect the force-degradation of elastomeric chains. Moreover, whereas Javanmardi and Salehi [17], and Mirhashemi *et al.,* (34) observed no impact, Omidkhoda *et al.,* (1) and Menon *et al.,* (3) revealed considerable force deterioration following immersion of chains in sodium fluoride mouthwashes. Behnaz *et al.,* (35) investigated the impact of daily sodium fluoride mouthwash (Listerine® Total Care Zero) and whitening mouthwash (Listerine® Healthy White) on the force degradation of elastomeric chains. They came to the conclusion—which is in line with the results of the current study-that regular use of Listerine® Total Care Zero mouthwash might accelerate the force degradation of elastomeric chains. However, they did not take into account the mouthwash's pH or other components. Pithon *et al.,* (36) looked at how four different types of chlorhexidine affected elastomeric chains at various concentrations and formulations. They discovered that none of the mouthwashes put to the test had any discernible impact on how quickly elastomeric chains lost force. Their findings concur with those of Mirhashemi *et al.*, [34].

While Omidkhoda et al. (1) observed a significant effect of chlorhexidine that may be related to the ethanol concentration (13.6%) of the examined mouthwash, Larrabee et al. (38) and Mahajan et al. (39) reported the influence of alcohol on the force degradation of the elastomeric chains. Numerous elastic bands' maximum forces and delivery forces were observed to decrease when exposed to the alkaline solution NaOH by Pureprasert et al. (41) in their study. This suggests that the pH of the mouthwash may be a decisive factor. At neutral and mildly acidic pHs, this impact was minimal, according to Lacerda dos Santos et al.'s (42) research. (5.0, 6.0, and 7.5).

Conclusion

The biggest rate of force deterioration, ranging from (46- 49)% in the first 24 hours, was followed by a steadier and more consistent pace over the whole testing period.

Despite the Super Elasto-Force chain creating a larger force level than the ordinary one at all times, The force level between (100&300) gm, which is clinically authorized to provide the appropriate force for orthodontic tooth movement, could be maintained by both types of elastomeric chains for six weeks. Following Listerine and Orthokin, the mouthwash with chlorhexidine had the third-smallest impact on the force degradation of elastomeric chains.

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