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EFFECTS OF DIFFERENT COMMERCIALLY AVAILABLE MOUTH RINSES ON THE FORCE DEGRADATION OF ORTHODONTIC ELASTOMERIC CHAIN

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ABSTRACT

Aim of the study: To evaluate the effects of different commercial type of mouthwashes on the force decay of the orthodontic elastomeric chain.

Materials and methods: two hundred pieces of the elastomeric chains with two different configurations were divided into five groups (one control group and four different mouthwashes groups). after one-day immersion in artificial saliva then immersion in the specific mouthwashes (kin, Vitis, perio_aid, splat) for one minute twice daily and time intervals after 7 days, 14 days, 21 days, and 28 then washed and kept in artificial saliva at 37°C again. Force decay was calculated by Instron measured, digital force gauge - Instron universal testing machine then compared different force decay of elastic types.

Results: A significant difference was found among between the four types of mouth wash and control group, according to close and short elastic chain the kin mouth wash was shows a significant difference (0.002), while splat mouthwash was shown a no significant difference.

Conclusion: splat mouth wash groups showed no significant influence on the force degradation of the chain elastics tested. Kin mouthwash exhibit the highest force decay and found different significant effects.

KEYWORD: Elastomeric chain**,** Force decay, mouthwashes and Instron machine.

INTRODUCTION

The elastomeric power chain is commonly used in orthodontics to facilitate tooth movement and consolidate space. These polyurethane materials are manufactured as a spool of a linked elastic chain, which can be cut to the specific number of modules needed (6). As elastomeric chains are made of polyurethane and because of their viscoelastic properties, they lose their force over time (16). Synthetic elastomeric chains have been in use in orthodontics for more than 6 decades. It is well-understood today that elastomeric chains lose their force substantially once they are stretched.(7) and (11) have mentioned that during the first day of use the force loss is maximal; then the force decay continues to decrease at a much consistent rate. Some factors can affect this force loss such as temperature (4) and (8) pH changes (9)

Elastomeric chains have been widely used in Orthodontics since the 1960s and its effect have been evaluated since then, they are used to deliver continuous light forces during sliding mechanics in space closure rotational correction and mainly during canine retraction after premolar extraction (19) and (20). When stretched and exposed to the oral environment, the chains may absorb humidity and suffer a breakdown of internal bonds, which leads to permanent deformation (5). Extensive literature now exists on the properties, behavior, and modes of action of elastomeric chains which emphasize that thermal cycled samples experienced less force decay than samples stored at room temperature, i.e.37°C (13). Other studies have also found that after this significant initial drop in the force applied, force degradation occurred at a much more stable rate (5).

Mouthwashes are prescribed widely for patients with a fixed orthodontic appliance in addition to the tooth brush and interdental aids. The purpose of this was to perform a systematic search on antiseptics used to control supragingival biofilm and gingivitis in orthodontic patients. The action of chlorhexidine

on the mechanical properties of these elastics, such as the force degradation over time. These mouthwashes mainly contain chlorhexidine and some contain sodium fluoride. Chlorhexidine is considered the superior mouthwash although it has many side effects like tooth discoloration, taste disturbance, desquamation of the mucosa, and augmentation of calculus deposition (26). Evaluating the probability of force transmission disability in systems is essential because in such situations the orthodontist cannot estimate the actual force transferred to the dentition, considering the probable effect of mouthwashes on reducing elastomeric chain forces (1). Aim of the study to evaluate the effects of different commercially type of mouthwashes on the force decay of orthodontic elastomeric chain.

MATERIALS AND METHODS

1. Sample selection

A total of 200 sample of the elastomeric chain (100 short and 100 close elastomeric chains) as shown in Figure (1) each specimens was consist of 7 loops- were divided into five groups (n=20 in each group). Ten plastic blocks with 20 pairs of stainless steel pins, to maintain each sample at its specific length were prepared to carry samples without relaxation. The distance between the pins for the close elastomeric chain were 20 mm, and 24 mm for short elastomeric chain as shown in Figure (3).This distance was measured by stretching 5 specimens to produce (200±5g) of force by force gauge. Four test groups were exposed to four different commercially available and commonly used mouth rinses (kin, Vitis, Perio·Aid, Splat White mouthwashes) as shown in Figure (2) at 37C°, the five groups of control specimens was immersed in artificial saliva at 37C° in an incubator throughout the entire experimental period, the Force measurements was performed at six-time intervals (initial,1 day, 7 days, 14 days, 21 days, and 28 days) by force decay measurement device as shown in Figure (4).

2. Sample preparation

In the case of mouth rinses, the samples were initially incubated in artificial saliva solution at 37°C in an incubator. Then retrieved and immersed the mouthwash solution in glass containers for 1 minute twice daily. These two daily exposures were separated by 12 hours. At the end of the first immersion period, immersed it again in another saliva container, specific for each mouth rinse for 30 minutes to mimic the use of the mouthwash by the patient. Then they were rinsed in water to prevent the entrance of the mouth rinse into the main saliva container and again were returned to the saliva container at 37°C. Measurement of the force generated for each sample was performed by means of a digital force gauge -Instron universal testing machine (force decay measurement device) at five-time intervals. The force gauge was kept in its specific stand to perform all the measurements at the identical horizontal and vertical direction.

Statistical methods

The level of decay in the orthodontic elastomeric chain for the study groups was determined in mean and Standard deviation. The comparison of decay level across agents in closed and short concertos was examined in ANOVA-one way. The comparison of mean values between closed and short connectors and comparison of mean difference (28 days-first day) between closed and short connectors and across agents were examined in independent t-test and one way ANOVA. At significant level ($p \leq 0.05$). The statistical calculations were performed by Statistical Package for Social Sciences version 25 (SPSS 25).

Fig, (1): Elastomeric chains

Figu. (2): types of mouthwashes

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Fig. (3): plastic block

Fig. (4): Instron universal testing machine

RESULTS

Table (1) explains the comparison of mean values between closed and short elastic chain as a result of using in five groups, four experimental different mouthwashes (splat, kin, vitis and perio) and one control group (artificial saliva). The results of P value illustrated that the close elastic chain showed minimum force decay (decrease force decay from normal) with splat mouth wash treatment (3.34) when compared with the kin mouth wash that show maximum one (2.63). In The short elastic chain the minimum force decay was also demonstrated with splat mouth wash (3.32) when compared to Kin,Vitis, mouthwash that record the highest mean.

Table (1): Comparison of at which time between closed and short elastic chain and across agents.

Agents (n=20 for each)	Closed-connectors	Short-connectors	*P-value
	Mean ± SD	Mean ± SD	
Control	2.92 ±0.17	2.98 ±0.29	0.430
Splat	3.34 ±0.22	3.32 ±0.20	0.765
Kin	2.63±0.25	2.86±0.19	**0.002**
Vitis	2.84±0.21	2.85±0.17	0.869
Perio	2.80±0.21	2.85±0.26	0.508
**P-value	<0.001	<0.001	

*Independent t-test and **One-way ANOVA were performed for statistical analyses.
The mean difference is significant at the .05 level.

Figure (5) shows the different mean value of force decay between close and short elastomeric chain which appear that the splat mouthwashes had a little effect of force decay on close elastomeric chain as compared to short elastomeric chain, while Vitis, Perio-aid mouthwashes and Kin had minimum effect of force decay on short elastomeric chain as compared to close elastomeric chain.

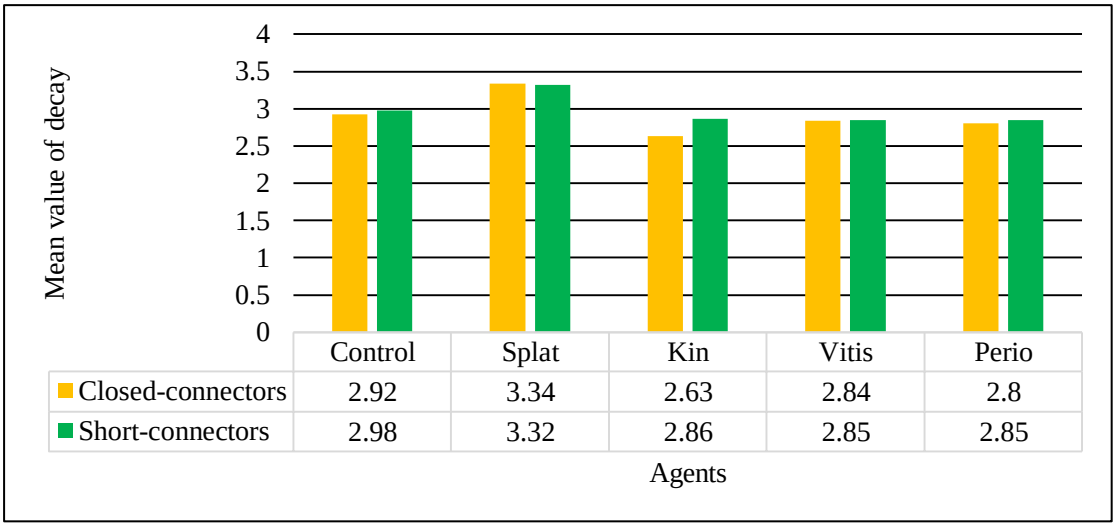

Fig. (5): Comparison of mean values between closed and short elastomeric chain.

Table (2) shows comparisons of difference in force decay of orthodontic elastomeric chain between the first day and 28 days among study groups (in both close and short colorless elastomeric chain). Firstly, when control group compared with all experimental groups, there was a highly significant difference, (control group show the least mean than other experimental groups), and the splat mouthwash was the lowest one in both types of elastomeric chain. The comparison of the experimental mouthwash groups of in both close and short chains was shown a significant difference, except the perio_aid shown non- significant difference.

Table (2): Comparison of mean difference (28 days-first day) between closed and short elastic chain and across agents.

	Closed chain	**Short chain**	
Agents	**Mean ± SD**	**Mean ± SD**	***P-Value**
Control	-0.38±-0.10	-0.35±0.07	0.279
Splat	0.48±-0.38	0.35±-0.10	0.147
Kin	-0.41±-0.40	-0.51±-0.26	0.354
Vitis	-0.40±-0.17	-0.51±-0.10	0.017
Perio	-0.44±-0.34	-0.38±-0.35	0.586
**P-value	0.856	0.016	

*Independent t-test and **One-way ANOVA were performed for statistical analyses.
The mean difference is significant at the .05 level.

Table (3) revealed the influence of four different mouthwashes (splat, kin, Vitis and perio) and control on the force decay loss of two configurations of orthodontic chains (closed and short elastic chain) at 5 times interval (1^{st} , 7^{th} , 14^{th} , 21^{th} and 28 days) were used as well as to control. Results of comparing the force degradation at time interval in the first 24 hours, shows the least force degradation with using splat mouthwash as presented by the lowest mean force decay than other elastics rinsing with other mouthwashes treatment. Force decays increased in all groups of mouthwashes except splat mouthwash through 7 days then the increase was not much in closed and short elastic chain. Whereas in the period of 21 days, the

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mean value of force decay of the kin group elastics was higher than that of all other groups. While the force declined progressively in the control group up to the end of the experiment (28 days), the entire degradation in force in the experimental groups would occur up to the time of 14 days. In the group treated with splat mouth wash it was also observed that there was no statistical reduction in force decay, contrary to that verified in the control group and other experimental groups. In all solutions, from the beginning to the end of week 4, significant force loss was observed in short and closed chains ($P < 0.05$), while splat mouthwash caused less force loss compared to other groups.

Table (3): Mean of force decay in short and closed elastic chains in different environments and times (measurement by N).

Agents (n=20 for each)	Time	Closed chain	Short chain
		Mean ± SD	Mean ± SD
Control	first day	3.09 ± 0.24	3.15 ±0.33
	7 day	3.00 ±0.18	3.07 ±0.16
	14 day	2.91 ±0.10	2.97 ±0.27
	21 day	2.90 ±0.17	2.92 ±0.29
	28 day	2.71 ±0.14	2.80 ±0.40
Splat	first day	3.04 ±0.48	3.10 ±0.29
	7 day	3.35 ±0.25	3.32 ±0.22
	14 day	3.31 ±0.18	3.30 ±0.12
	21 day	3.46 ±0.10	3.42 ±0.18
	28 day	3.52 ±0.10	3.45 ±0.19
Kin	first day	3.04 ±0.59	3.06 ±0.33
	7 day	2.52 ±0.25	3.02 ±0.30
	14 day	2.48 ±0.07	2.90 ±0.18
	21 day	2.50 ±0.14	2.77 ±0.07
	28 day	2.63 ±0.19	2.55 ±0.07
Vitis	first day	3.00 ±0.27	3.04 ±0.23
	7 day	2.96 ±0.35	3.00 ±0.27
	14 day	2.85 ±0.21	2.91 ±0.13
	21 day	2.78 ±0.12	2.75 ±0.09
	28 day	2.60 ±0.10	2.53 ±0.13
Perio	first day	3.02 ±0.36	3.00 ±0.47
	7 day	2.98 ±0.22	2.97 ±0.29
	14 day	2.72 ±0.40	2.85 ±0.26
	21 day	2.69 ±0.04	2.80 ±0.16
	28 day	2.58 ±0.02	2.62 ±0.12

The difference over time was significant for all agents.
One-way ANOVA was performed for statistical analyses.

DISCUSSION

Elastomeric chains got wide popularity in daily orthodontic practice because they are economic, relatively hygienic, required less chair time (2) and some types contain fluoride that reduced enamel decalcification (10). On the other hand, they were made of industrial polyurethanes which were not inert materials so with long-drawn-out contact with enzyme, water or heat they will decompose (10). The clear type was undergoing discolouration by foods and drinks causing aesthetic problems. Moreover, these elastics exhibited load relaxation when stretched beyond their elastic limit and this force loss made it temporary for practitioners to determine the actual force applied to dentition (23).

In the current study the elastic chain for the close stretching elastomeric chain was 20 mm, while the short elastomeric chain was 24 mm with purpose of similarity the mean distance of maxillary canine to maxillary first molar on same time of dental arch. Although elastomeric

chains are widely used in orthodontics to tooth move and close the space, force loss over time is inevitable. Several studies have examined the force degradation of elastomeric chains. Many factors influence the rate of force decay including the manufacturer of the chain, in the (*in vitro* or i*n vivo*), the shape of the chain, different environments, temperature and potential of hydrogen (pH) consummation buffering and using different periodontal mouthwash. (15) and (17). In this study was used solution and mouthwash kin, Vitis, splat and perio aid mouthwashes, artificial saliva. (12) and (14) who reported that the force loss in a dry environment is more than a wet environment. Artificial saliva was considered for the control group to simulate oral condition.

According to this study, the force decay in splat groups was low than those of the control group and they are shows the no significant difference. Splat is a combination of as active agents (including: splat white plus mouthwash aqua, glycerin, tetrasodium glutamate diacetate, benzyl alcohol, polyglyceryl-4 laurate/ sebacate this agreement with (18). In spite of the pattern of decline in force in the groups treated with alcoholic beverages having differed from that observed in the control group at the end of the experiment in the time interval of 28 days, there were no significant differences between the treatments. Although there was a difference in the values between the groups in two-time intervals. (22) Have illustrated that the effects of the number of alcoholic beverages on force degradation of the elastomeric chain were evaluated and at the end of the study, no significant differences were found between alcoholic beverages and other group. But, Effect of containing alcohol mouthwashes on the structure and molecular changes in elastomeric chains and the following force degradation (6). While according to (16) who exposed the chains to alcohol-containing mouthwashes showed a higher amount of force loss in comparison with other type. So, to eliminate the probable effect of alcohol on chain's force, alcohol-free Listerine mouthwash used in this study. But still,the amount of force decay was higher than the control group (16). Maybe there are other causes that the splat mouth wash act as whitening leading to lowest force decay of elastomeric chain. (3) The main finding of this study was dramatic force decay of elastomeric chains immersed in whitening mouthwash from 1 to 28 days after activation. The active ingredient of bleaching mouthwash was hydrogen peroxide which could react with organic molecules and change optical properties of the teeth (3). (24) Who revealed that there was no significant difference between immersions of elastomeric chains in two types of whitening mouthwashes was hydrogen peroxide-containing whitening. However, the results of the current study showed a significant decrease in elastomeric chain force immersed in whitening mouthwash compared with artificial saliva.

The comparison of mean values between closed and short and comparison of mean difference (28 days-first day) between closed and short were examined in independent t-test and A-one way ANOV was done to comper control group with other we found firstly when control group compared with other group of mouthwashes the force decay in control group less than other except splat mouthwash, Compering kin and vitis mouthwash group of close chain with other two mouth washes in short chain we found the difference significant, while the splat and perio_aid shows the no significant difference.

Mean of force decay in short- and closed elastic chains in different environments and times, in closed elastic, the control group reached big value between first day and 7 days and then decreased from 14 days to 28 days. The kin and vitis and perio_aid mouthwash group reached a big value between first days then decrease between 7 and 28 days. The splat mouthwash group showed phase be big value between 21 and 28 days. However, compared to other groups, splat group showed much low force decay from initial to 7 days. In the short elastic the result is almost like close elastic. The different mean value of force decay between close and short elastomeric chain which appear that kin mouthwash is the most one that effect on force decay of elastic chain, the second one was Vitis and the better one less effected was splat mouthwash. There are many risen the kin content specific oral hygiene for orthodontic appliance wearers. Formulated with fluoride, cetylpyridinium chloride, provitamin B5 and vitamin E para Prevention of caries, Prevention of dental plaque.

Sodium fluoride mouthwash caused greater force loss, which was in agreement with the results of (21) in which sodium fluoride 0.05 caused greater force decay loss in comparison with control group. However, in the study of (25) no significant differences were observed.

This agreement with this study the kin mouthwash cause greater force loss.

CONCLUSION

Splat mouthwash have a lowest effect in force decay of elastomeric chains over the time, while Kin and vitis triggered the highest force decay ,beside that Daily use of sodium mouthwash could increase force decay of elastomeric chains at days 1 and 28 after activation.

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