ORIGINAL RESEARCH

In Vitro Evaluation of the Efficacy of Different Mouthwashes on Force Decay of Orthodontic Elastomeric Chains

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ABSTRACT

Background: Elastomeric chains are widely used in orthodontics as an active component. Elastics have been an appreciated aid to many types of orthodontic movement for years. Hence, the present study was conducted to evaluate the efficacy of different mouthwashes on the force decay of elastomeric chains.

Materials and Methods: A total of 60 samples of orthodontic elastomeric chains were used in this study. These were divided into two experimental groups and one control group. Group 1: 20 elastomeric chains in neem mouthwash, Group 2: 20 elastomeric chains in sodium fluoride mouthwash, and Group 3: 20 elastomeric chains in artificial saliva. These elastomeric chains were 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 3 times intervals (baseline, 7th day, and 21st day). The means of force decayed were analyzed using analysis of variance test to compare between the test groups and the effect of immersion time within each group. Tukey *post hoc* was used to find out the differences in force decayed. *P*-value was set at <0.05.

Results: At baseline, sodium fluoride group showed the highest mean force value (289.47 ± 11.22) followed by neem mouthwash (286.32 ± 10.14) and artificial saliva (284.87 ± 10.49). However, there was no significant difference between the groups. On 7th day and 21st day, there was a significant difference between the groups. Tukey's *post hoc* test showed that there was a statistical difference between Group 1 versus Group 2 and Group 2 versus Group 3.

Conclusion: Within the limitations of the present *in vitro* study, sodium fluoride mouthwashes could cause more force decay of orthodontic elastomeric chains compared to neem mouthwash.

Keywords: Elastomeric chain, Force decay, Neem mouthwash, Sodium fluoride mouthwash.

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INTRODUCTION

An individual's wearing orthodontic appliance has to 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]

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. 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 using mouthwashes.[2]

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 anteroposterior and vertical inconsistencies. When the elastomeric chains are activated, they will be permanently stretched, thus reducing the force applied on the teeth.[3]

In the normal condition of the oral cavity, numerous factors can affect the force production and degradation of traction aids, such as pH variation, fluoride ions and rinses, saliva, temperature fluctuation, oxygen content, free radicals, salivary enzymes, and masticatory forces. This force loss made it thorny for orthodontists to decide the real force transmitted to the teeth.[4]

Mouthwashes are prescribed widely for patients with the fixed orthodontic appliance in addition to toothbrush and interdental aids.[5]

Mouthwashes have been used for centuries for medicinal and cosmetic purposes, but it is only in recent years that the rationale behind the use of chemical ingredients has been subject to scientific research and clinical trials. Today's dentists are practicing in an era where the patients are more concerned about both their oral health and their overall medical well-being.[6] Hence, the present study was conducted with an aim to evaluate the efficacy of different mouthwashes on force decay of orthodontic chains.

MATERIALS AND METHODS

A total of 60 samples of orthodontic elastomeric chains were used in this study. All samples showed medium conformation, gray color and were within the expiry date. They were stored according to the manufacturer's instructions up to the time of use.

The chains were prestretched to 100% of their initial length for 10 s. A jig with two posts secured on it with screws was designed. The distance between the posts was fixed at 25 mm to simulate the distance between the first molar hook and distal wings of the canine bracket. Each piece of chain was stretched between two posts. In this way, a constant force was exerted on the elastomeric chain during the test period.

Sixty pieces of chains were divided into two experimental groups and one control group.

Group 1: 20 elastomeric chains in neem mouthwash

Group 2: 20 elastomeric chains in sodium fluoride mouthwash

Group 3: 20 elastomeric chains in artificial saliva.

These elastomeric chains were fully submerged in the test solutions. The test groups were exposed to the test solutions, for 60 s twice daily; force measurements were obtained at 3 time intervals (baseline, 7th day, and 21st day).

The test groups were independently immersed in distilled water at 37°C and kept in an incubator. The temperature was monitored using a digital thermometer. The samples were immersed in the test samples as allocated for 1 min then washed with distilled water to simulate salivary rinsing effect in the oral cavity. After that, the samples were returned to the incubator. An Instron machine (Instron Corporation, Canton, Massachusetts, USA) with the rate of 30 mm/min was used to measure elastomeric chain force by a skilled operator who was blind to the type of intervention. Amount of force was measured while elastomeric chains were stretched to 25 mm.

Statistical Analysis

The analysis was done using the software statistical package for the social sciences (version 20). The means of force decayed were analyzed using analysis of variance test to compare between the test groups and the effect of immersion time within each group. Tukey *post hoc* was used to find out the differences in force decayed. *P*-value was set at <0.05.

RESULTS

Table 1 shows the mean force values of orthodontic elastomeric chain at baseline. Sodium fluoride group showed the highest mean force value (289.47 ± 11.22) followed by neem mouthwash (286.32 ± 10.14) and artificial saliva (284.87 ± 10.49). However, there was no significant difference between the groups.

Table 2 depicts the mean force values of orthodontic elastomeric chain on the 7th day. Mean force value of neem mouthwash was 192.46 ± 8.34, sodium fluoride group was 171.27 ± 6.10, and artificial saliva was 198.11 ± 9.53. Moreover, there was a significant difference between the groups.

Table 3 reveals the mean force values of orthodontic elastomeric chain on the 21st day. Mean force value of neem mouthwash was 163.28 ± 6.11, sodium fluoride group was 138.65 ± 5.98, and artificial saliva was 173.43 ± 7.28. Moreover, a statistically significant difference was found between the groups.

Table 4 describes multiple comparisons of different groups using Tukey's *post hoc* test. There was a statistical difference between Group 1 versus Group 2 and Group 2 versus Group 3.

DISCUSSION

Elastomeric chains are force generating units used to deliver force to move the teeth in a predetermined manner. They were widely used in orthodontic practice since the 1960s for effective tooth movement with minimal adverse effects. Elastomeric chains are polyurethanes, possessing low molecular weight polymer (usually polyester or polyether) to produce a complex structure of urethane linkage. Polyurethane polymers possess rubber-like elasticity and have long-chain, lightly cross-linked structures with a weak molecular attraction consisting of primary and secondary bonds. Before stretching, elastomeric chain consists of folded linear molecular chains. On extension, these molecular chains unfold in an ordered linear fashion at the expense of the secondary bonds. An ideal elastomer material turns back to its exact major shape when it is stretched. This rarely happens in the reality because when some of the polymeric chains are stretched, they slide irreversible and layout in a new way.[7] The applied force makes the molecules of polymer uncoiled; at first, the activated chain is stretched, but as the time passes, the molecules

Table 1: Mean force values of orthodontic elastomeric chain at baseline

Mouthwash groups	Mean±SD	Std. Error	F	*P* value
Group 1 (Neem mouthwash)	286.32±10.14	0.1221	27.281	0.734
Group 2 (Sodium fluoride)	289.47±11.22	0.1202		
Group 3 (Artificial saliva)	284.87±10.49	0.0740		

SD: Standard deviation

Table 2: Mean force values of orthodontic elastomeric chain on the 7th day

Mouthwash groups	Mean±SD	Std. Error	F	*P* value
Group 1 (Neem mouthwash)	192.46±8.34	0.0652	26.881	0.001
Group 2 (Sodium fluoride)	171.27±6.10	0.3432		
Group 3 (Artificial saliva)	198.11±9.53	0.1642		

SD: Standard deviation

Table 3: Mean force values of orthodontic elastomeric chain on the 21st day

Mouthwash groups	Mean±SD	Std. Error	F	*P* value
Group 1 (Neem mouthwash)	163.28±6.11	0.2876	27.453	0.001
Group 2 (Sodium fluoride)	138.65±5.98	0.3122		
Group 3 (Artificial saliva)	173.43±7.28	0.1872		

SD: Standard deviation

Table 4: Multiple Comparisons of different groups using Tukey's *post hoc* test

Groups	Compared with	Mean difference	Sig.
Group 1	Group 2	24.63	0.001
	Group 3	-10.15	0.06
Group 2	Group 1	-24.63	0.001
	Group 3	-34.78	0.001
Group 3	Group 1	10.15	0.07
	Group 2	34.78	0.001

slip on each other, which results in a new layout and permanent deformation. Slippage of the molecules as a result of the force continuity reduces the force transfer to the teeth.[8]

Artificial saliva was chosen as a control group because in some studies force degradation was higher in wet than in dry environments.[9,10]

The present study shows that elastomeric chains in all mouthwashes had significant force losses at all times. Almost all previous studies showed that in any test environment, the highest force loss occurred during the first 24 h and then progressed in a more steady and gradual rate.[11,12] In the present study, during the 1st week, the force loss was more. This range of force loss was similar to Motta *et al*.[13] and Buchmann *et al*.[14] studies. In other study showed a higher range of force loss (up to 75% of the initial force) in the first 24 h.[15] This difference was found to be highly dependent on the experimental conditions as the force loss is higher in wet *in vitro* conditions than in the air or dry conditions. It has also been shown that force decay is higher in *in vivo* compared to wet *in vitro* conditions.

The study conducted by Oshagh *et al*.[16] shows a significant force decay of elastomeric chains immersed in sodium fluoride mouthwash compared with control group (57.4, 63.1, and 66.1% decay after 1, 7, and 21 days, respectively). Another study revealed 57.49% force decay after 3 weeks of the use of sodium fluoride mouthwash which was not significant compared with control group.[17] Omidkhoda *et al*.[18] measured force decay of elastomeric chains (Dentaurum) in sodium fluoride mouthwash and the following thermocycling and reported 24.01, 27.60, 33.69, 41.21, and 56.81% of force decay after 1, 7, 14, 21, and 28 days, respectively. In their study, the difference was significant compared with the control group. In the current study, force decay of elastomeric chains immersed in sodium fluoride mouthwash was more on the 7th and 21st days.

One of the limitations of this study was due to *in vitro* setup. Although *in vitro* studies permit controlling confounding factors, several influencing factors might be ignored while their effect might be significant. It has been reported that several factors including microbial flora, diet, and functional forces could influence the force of elastomeric chains *in vivo*.[19]

CONCLUSION

Within the limitations of the present *in vitro* study, sodium fluoride mouthwashes could cause more force decay of orthodontic elastomeric chains compared to neem mouthwash.

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