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Research Article

THE EFFECT OF AN ANTIMICROBIAL MOUTHWASH ON THE MODULUS OF ELASTICITY OF DIFFERENT ELASTOMERIC LIGATURES, AN *IN VIVO* STUDY

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Abstract

Introduction: Elastomeric ligatures are the most popular method of ligation. There is increased level of bacterial plaque around these auxiliaries. Orthodontic patients are recommended to use antimicrobial mouthwash against bacterial plaque accumulation. Since mouthwashes may influence mechanical properties of elastomeric rings, the aim of this clinical study was to investigate the effect of Ortho-kin mouthwash on the modulus of elasticity (MOE) of four different elastomeric rings. **Methods:** fifteen patients (8 female and 7 male, age 15±3 years) were randomly selected. The design of the investigation was split mouth study. In the first stage, in each patient, four trademarks of elastomeric rings (Falkon, ODP, Ortho technology and Astar) were randomly tied on the canine teeth. After 28 days elastomeric rings were removed and the MOE was measured. In the second stage, the elastomeric rings from the same brands were tied on the same teeth. The patients used Ortho-kin mouthwash for 28 days based on manufacturer's instruction. Afterward, elastomeric ligatures were removed and MOE was measured. Generalized estimating equation test was used to compare the MOE of each ligature before and after mouthwash consumption. Pairwise comparison test was used to compare the MOE between the groups. **Result:** Before mouthwash use, ODP yielded the highest MOE (2.16 ± 0.02) and Falkon showed the least (1.02 ± 0.01). There was significant difference between MOE of all groups (all $p< 0.001$). In all groups MOE significantly decreased after mouthwash consumption (all $p < 0.001$). Similarly, after mouthwash use ,ODP yielded the highest MOE (1.92 ± 0.05) and Falkon showed the least (0.78 ± 0.01). There was significant difference between the MOE of all the elastomeric rings($p< 0.001$) except between Ortho technology and Aster ($p= 0.78$). **Conclusion:** There is significant difference between MOE of the elastomeric rings. Furthermore, mouthwash products can influence mechanical properties of elastomeric rings and must be considered when prescribed for patients.

Keywords: elastomeric ligature, modulus of elasticity, Ortho-kin mouthwash.

Introduction

Orthodontists conventionally usesteel wires, elastomeric ligatures or self-ligatingbrackets to transmit the force to the teeth[1-3]. Among these methods, elastomeric rings have become the most popular because of ease of application, patient comfort, and color diversity[4, 5].

Elastomeric ligatures are polyurethane. Polyurethane refers to the elastomeric polymers which contain the urethane linkage. Polyurethanes are synthetized by reaction of p olyester or polyether or polyhydrocarbon diol with a di-isocynate. Ultimately, a complex structure with a urethane linkage will be formed[2,4, 6].

Besides the advantages, elastomeric rings have well-documented shortcomings. Their mechanical properties are influenced by oral environment, masticatory force, and mouth rinses[5, 6]. Taloumis et al.[4] reported 50% force degradation in first 24 hours in in vitro environment.

MOE represents a relative rigidity of a material. It is measured from slope of the elastic region of stress-strain

graph[7, 8]. The higher the MOE, the greater the engagement of the wire and the bracket would occur. An elastomeric ligature with high MOE is beneficial in the torque and rotation corrections[9]. On the other hand, in sliding mechanics, method of ligation affects the value of binding[10, 11]. Since a low level of binding is desired, the elastomeric ligatures with a low level of MOE would be a good choice. Russel et al.[12] compared the MOE of latex and non-latex ligatures. They showed that the mechanical properties of elastomeric ligatures depend on the type of the material and the manufacturer. Jalali et al.[9] compared the MOE of seven different elastomeric ligatures after 28 days storage in artificial saliva and reported that there is significant difference between the MOE of the elastomeric ligatures before and after storage that is related to special composition of each trademark.

In addition, these auxiliaries facilitate plaque accumulation around orthodontic brackets and consequently increase the risk of enamel demineralization and periodontal pathology[3, 4, 13]. Because mechanical approaches are usually insufficient to maintain the oral hygiene, the use of a mouth rinse is recommended to orthodontic patient[14].

Since mouth washes are commonly used by the orthodontic patients[1] it is necessary to investigate their effects on the mechanical properties of the elastomeric ligatures. Until now several studies have been done about the effect of temperature, PH, and oral environment on mechanical properties of elastomeric materials[15-18]. The evaluated characteristics were force decay[4], tensile strength[19], and breaking force[12]. However, the MOE has been evaluated in only two in vitro investigations[9, 12] and there is no study which examined the effect of a mouthwash on this mechanical property.So the aim of this in vivo study was to assess the effect of Ortho-kin mouthwash on the MOE of four different brands of elastomeric ligatures.

Materials and Methods

In this clinical study 15 subjects (8 female and 7 male, age 15±3 years) were randomly selected from the patients undergoing fixed orthodontic treatment at the orthodontics department of Ahvaz dental school. The patients were selected from those who have attended the treatment appointments regularly. The subjects with any history of allergic reaction to mouth wash were excluded. Informed consent was obtained from all the participants.

The design of the investigation was split mouth study. In the first stage, four trademarks of elastomeric rings including Ortho technology (Ortho technology, Florida, USA), ODP (orthodontic design and production, California, USA), Astar (Astar orthodontics, Shanghai, China), and Falkon (Hangzhou Yamei Dental Medical Equipment, Hangzhou, China) were used for ligation. In all patients the elastomeric rings were randomly tied on the canine teeth. The patients were asked not to consume any type of mouth rinse. After 28 days the elastomeric rings were carefully removed and placed in physiologic serum and transferred to professor Torabinezhad research center (Isfahan, Iran) for the analysis. Electromechanical universal testing machine (k-21046, walter+bai, Switzerland) was used to measure the MOE of the samples. Each elastomeric ring was hold with two stainless steel hooks and strained with speed of 5mm/min until rupture. Simultaneously the stress-strain curve was drawn by the machine.

In the second stage, the elastomeric rings from the same brands were tied on the canine teeth. Each brand was tied on the same location as the previous stage. The Ortho-kin mouth rise (Ortho-kin, Kin, Spain) was prescribed for patients and asked to use the mouth rinse two times a day based on the manufacturer's recommendation. After 28 days the elastomeric rings were carefully removed and transferred to the professor Torabinezhad research center (Isfahan, Iran) for MOE measurement. The samples were analyzed with Electromechanical universal testing machine (k-21046, walter+bai, Switzerland) as described before.

Descriptive statistics including the mean and standard deviation were calculated for all groups. Generalized estimating equation (GEE)test was used to compare the MOE for each elastomeric ring before and after mouth wash use. Pairwise comparison test was used to compare the MOE between the groups. SPSS software (version 17.0, SPSS Inc; Chicago, Illinois, USA) was used for analysis of the data. P-value ≤ 0.05 was considered as a significance level.

Results

The MOE values are demonstrated in table 1. GEE test showed that in all groups MOE significantly decreased after mouthwash consumption (all $p < 0.001$). The MOE of the elastomeric ligatures before and after mouthwash use is illustrated in figure 1.

Pairwise comparison test showed that before mouthwash consumption there was significant difference between the MOE of all the elastomeric rings (all $p< 0.001$). The highest MOE was dedicated to ODP (2.16 ± 0.02) and Falkon showed the least (1.02 ± 0.01). Likewise, after mouthwash consumption, there was significant difference between the MOE of all the elastomeric rings($p< 0.001$) except Ortho technology and Aster ($p= 0.78$). ODP yielded the highest MOE (1.92 ± 0.05) and Falkon showed the least (0.78 ± 0.01). The outcome of pairwise comparison test is presented in table 2.

Table I. MOE values and summary of GEE analysis before and after mouthwash use

		Elastomeric ring			
		MOE (mean ± SD)			
		Falkon	ODP	Ortho technology	Astar
Mouthwash	Before	1.02 ± 0.06	2.16 ± 0.10	1.99 ± 0.09	1.78 ± 0.17
	After	0.78 ± 0.05	1.92 ± 0.20	1.48 ± 0.05	1.39 ± 0.17
	P-value*	<0.001	<0.001	<0.001	<0.001

*: Using GEE test

Table II. Summary of Pairwise comparison analysis before and after mouthwash use

Elastomeric ring		P-value*	
		Before	After
Falkon	ODP	< 0.001	< 0.001
	Ortho technology	< 0.001	< 0.001
	Astar	< 0.001	< 0.001
ODP	Ortho technology	< 0.001	< 0.001
	Astar	< 0.001	< 0.001
Ortho technology	Astar	< 0.001	0.78

*: Using pairwise comparison test

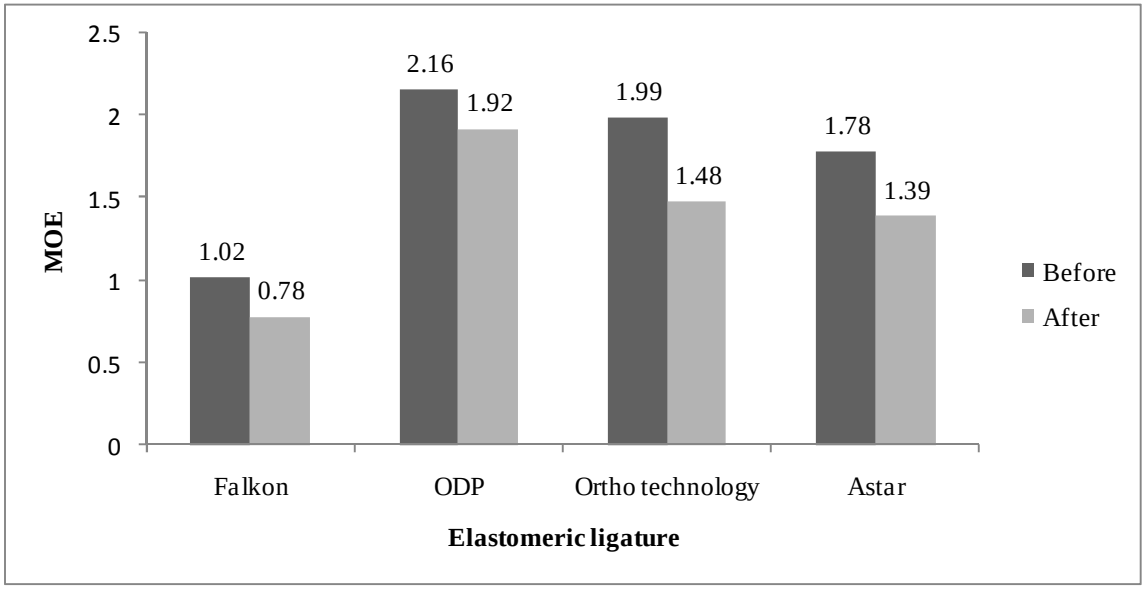

Figure I. MOE of elastomeric ligatures before and after use of Ortho-kin mouthwash

Discussion

By introduction of the elastomeric ligatures in 1960 they have become the most popular method of ligation[5]. The advantages over steel ligatures include easy application that reduces the chair time, patient comfort, and availability in different colors[4, 5]. Nevertheless, these auxiliaries are not inert material and can be influenced by the environment[4]. They undergo degradation in contact with oral enzymes, thus necessitate periodic replacement[20]

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MOE represents the relative stiffness of the material[7, 8]. Elastomeric ligature with high MOE connects the wire and the bracket tightly. This characteristic is beneficial in rotation and torque correction. On the other hand, in sliding mechanics, a low level of binding is favorable. As a result, it is better to apply the ligatures with low MOE value[9].

Orthodontic patients are at high risk of enamel demineralization and periodontal problems during the treatment[3,21, 22]. Most of them need antimicrobial therapy in conjunction with mechanical methods to maintain their oral health[1, 14]. Antimicrobial mouthwashes have special composition that may alter the mechanical properties of the orthodontic appliance[16]. In this context we examined the effect of Ortho-kin mouthwash on the MOE of four different elastomeric ligatures.

We found that before mouthwash use there is significant difference between the MOE of the elastomeric ligatures (all $p < 0.001$). ODP yielded the highest MOE (2.16 ± 0.02) and Falkon showed the least (1.02 ± 0.01). After mouthwash use, the MOE decreased significantly in all groups (all $p < 0.001$). The MOE of the ligatures were significantly different ($p < 0.001$) except between Ortho technology and Aster ($p= 0.78$).ODP showed the highest MOE (1.92 ± 0.05) and Falkon showed the least (0.78 ± 0.01).

Jalali et al.[9] compared the MOE of seven brands of elastomeric ligatures before and after 28 days storage in artificial saliva. The brands were American Orthodontics, Ortho Technology, Dentaurum,GAC, All Star, Techno Tak and ITO. They reported that before placement in the saliva, Dentaurum showed the highest MOE (2/12 ± 0/11), while Ortho Technology (1/17 ± 0/07) and American Orthodontics (1/11± 0/06) had the least MOE. There was significant difference among the groups ($p< 0.05$) except between American Orthodontics and Ortho Technology. It is compatible with our results that initial MOE of the ligatures with different brands are not the same. The MOE measurements after storage in the artificial saliva showed that the environment can influence the MOE of the ligatures. Some elastomeric ligatures showed increased MOE while the other showed the reverse.ITO yielded the highest MOE (2/15 ± 0/09), while Techno Tak ،All Star ،Ortho Technology, and Dentaurum had the lowest MOE, respectively and there wasn't any significant difference between them ($P > 0.05$). In contrary, in our study all the ligatures showed decreased MOE as time passed. This may be due to obtaining the samples from different brands and different storage condition. The authors claimed that although the elastomeric ligatures have the similarbase, their precise composition is unique for each manufacturer. This may be the reason for different reactions of the samples.

Russel et al.[12] compared the mechanical properties of latex and non-latex ligatures. They obtained the samples from GAC and Masel manufacturers. The samples were light, medium, and heavy weights. They measured the cross-sectional area, breaking force, peak load, peak stress, stiffness,modulus, hysteresis, and 24-hour load relaxation. They reported that MOE of Masel ligatures was significantly higher than that of GAC. Masel non-latex ligatures had significantly higher MOE than latex ones ($p < 0.05$). In GAC ligatures, Heavy and light latex showed higher MOE than non-latex ligatures. Conversely, in medium ligatures non-latex ligatures had higher MOE. Irrespective of the manufacturer, latex ligatures had significantly higher MOE. The findingis in agreement of ourstudy that the MOE of elastomeric ligatures is somewhat dependent on the manufacturer.

In 2013, Pithon et al.[1] performed the study to examine the effect of mouthwashes with or without bleaching agent on the force degradation of the elastomeric chains. They divided the samples to six different storage conditions including artificial saliva, distilled water, Plax and Listerine mouthwashes which have no bleaching agent, and Plax Whitening and Listerine Whitening that contain bleaching agent. They exposed the chains to the mouthwash two times a day for 60 seconds. Force was measured in six time intervals (initial and 1, 7, 14, 21, and 28 days). As time goes on, the force delivery decreased significantly in all groups. Likewise, we found that the mouthwash can influence the mechanical property of the elastomeric material.

In a separate study, Pithon et al.[14] evaluated the effect of different concentrations of chlorhexidine mouthwash on the force decay of the elastomeric chains. The storage media were distilled water, 0.2% and 0.12% manipulated chlorhexidine, 0.12% Periogard, and 0.2%Cleanform mouthwash. They immersed the chains in the media, two times a day for 30 seconds and measured the force in six different times. In all groups, they reported significant force degradation over time. In addition, after 28 days, the chlorhexidine groups showed higher values of force than control group (artificial saliva). Between the chlorhexidine groups the two 0.12% made the highest decline in force. This investigation confirmed our findings that the mouthwashes have an impact on the mechanical properties of the elastomeric materials.

As a summary, it is essential to select the elastomeric ligature with appropriate MOE in different stages of the treatment. Furthermore, the effect of environmental factors such as antimicrobial mouthwashes on the

mechanical properties of the orthodontic ligatures must be considered.

Conclusion

- There is significant difference between the MOE of different trademarks of elastomeric ligatures.
- ODP ligature shows the highest MOE. Therefore, it can be beneficial in torque and rotation correction.
- In sliding mechanics, Falkon ligature may be good choice. Little binding would occur, because this elastomeric ligature shows the lowest MOE.
- Ortho-kin mouthwash does significantly reduce the MOE of the elastomeric ligatures.
- The effect of mouthwash on the MOE of elastomeric ligature must be considered in selecting an appropriate elastomeric ligature in different stages of orthodontic treatment.

References

1. Pithon M, Rodrigues A, Sousa E, Santos L, Soares N. Do mouthwashes with and without bleaching agents degrade the force of elastomeric chains? Angle Orthod. 2013;83(4): 712-7.
2. Wong AK. Orthodontic elastic materials. Angle Orthod. 1976; 46(2): 196-205.
3. Garcez AS, Suzuki SS, Ribeiro MS, Mada EY, Freitas AZ, Suzuki H. Biofilm retention by 3 methods of ligation on orthodontic brackets: a microbiologic and optical coherence tomography analysis. Am J Orthod Dentofacial Orthop. 2011; 140(4): e193-8.
4. Taloumis LJ, Smith TM, Hondrum SO, Lorton L. Force decay and deformation of orthodontic elastomeric ligature. Am J Orthod Dentofacial Orthop. 1997; 111(1): 1-11.
5. Graber LW. Vanarsdall RL., Vig KWL. Orthodontics—Current Principles and Techniques. 5th ed. St Louis, Mosby Elsevier; 2012:582.
6. Bratu DC, Pop SI, Balan R, Dudecu M,Petrescu HP,Popa G. Effect of different artificial saliva on the mechanical properties of orthodontic elastomeric ligatures. Material plastic.2013; 50(1): 49-52.
7. Proffit WR, Fields HW, Sarver DM. Contemporary Orthodontics. 5th ed. St Louis, Mosby Elsevier; 2013:313.
8. Sakaguchi RL, Powers JM. Craig's Restorative dental materials. 13th ed. St Louis, Mosby Elsevier; 2012:40.
9. Jalali T, Ahrari f, zebarjad SM. Comparative evaluation of elastic modulus of orthodontic elastomeric ligatures. J Dent (Shiraz).2009; 9(4):310-8.
10. Thurow RC. Letter: Elastic ligatures, binding forces, and anchorage taxation. Am J Orthod 1975; 67: 694.
11. Devanathan D. Performance study of a low friction ligature. LaPorte, Ind: Research Laboratory of TP Orthodontics; 2000.
12. Russell KA, Milne AD, Khanna RA, Lee JM. In vitro assessment of the mechanical properties of latex and nonlatex orthodontic elastic. Am J Orthod Dentofacial Orthop. 2001;120: 36-44.
13. Condò R, Casaglia A, Condò S. G, Cerroni L. Plaque retention on elastomeric ligatures. An in vivo study. ORAL and implantology. 2012; 5(4): 92-9.
14. Pithon MM, Santana DA, Sousa KH, Farias IM. Does chlorhexidine in different formulations interfere with the force of orthodontic elastics? Angle Orthod. 2013;83(2):313-8.
15. De Genova DC, McInnes-Ledoux P, Weinberg R, Shaye R. Force degradation of orthodontic elastomeric chains--a product comparison study. Am J Orthod. 1985;87(5):377-84.
16. Von Fraunhofer JA, Coffelt MT, Orbell GM. The effects of artificial saliva and topical fluoride treatments on the degradation of the elastic properties of orthodontic chains. Angle Orthod. 1992;62(4):265-74.
17. Teixeira L, Pereira Bdo R, Bortoly Tg, Brancher Ja, Tanaka Om, Guariza-Filho O. The environmental influence of Light Coke, phosphoric acid, and citric acid on elastomeric chains. J Contemp Dent Pract. 2008;9:17–24.
18. Crawford N, Mccarthy C, Murphy T, Benson P. Physical properties of conventional and super slick elastomeric ligaturesafter intraoral use. Angle Orthod.2010;80(1):175-81.
19. Elidas T, Elidas G, Silikas N, watts D. Tensile properties of orthodontic elastomeric chains. Eur J Orthod. 2004;26(2):157-62.
20. Danata S, Sengupta J, Sharma V. structural and mechanical characterization of newer elastomeric modules. J Lnd Orthod Soc. 2006;39:23-9.
21. Mitchell L. Decalcification during orthodontic treatment with fixed appliances–an overview.BrJ Orthod.1992;19(3):199-205.
22. Türkkahraman H, Sayin MO, Bozkurt FY, Yetkin Z, Kaya S, Onal S. Archwire ligation techniques, microbial colonization, and periodontal status in orthodontically treated patients. Angle Orthod. 2005;75(2):231-6.