

EVALUATION OF CHANGE - IN- SCHEDULE OF INTRA ORAL ORTHODONTIC ELASTICS IN A SIMULATED ORAL ENVIRONMENT – AN IN-VITRO STUDY

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ABSTRACT

This project evaluated the change- in -schedule of intra oral orthodontic elastics in a simulated oral environment. The bands of two manufacturers' American orthodontics and Dentarum were examined with three bands in each subgroup of two groups (I and II). The initial force delivered by randomly selected intra oral elastics was recorded for extensions of 225%, 300% and 450%. Then the elastics were engaged on to a special jig having posts at a distance of 14.8mm, 19mm and 28.4mm in order to extend the diameter of elastics by 225%, 300% and 450% respectively and incubated at 37°C in artificial saliva for 24 and 48 hours of time. Force degradation of intra oral elastics was calculated in grams. Data was analyzed using ANOVA. The force degradation was high during first 24 hours and the elastics should be changed on a daily basis.

KEY WORDS: Force Degradation, Elastics, Elastomeric, Stretching.

INTRODUCTION

Orthodontic rubber bands are used in orthodontics because they can exert pressure on certain teeth to bring about the desired tooth movement. They are designed to be small enough and thick enough to create the proper amount of pressure on your teeth. While appliances can align the teeth properly, rubber bands exert pressure to move the teeth forward and backwards and close the spaces between the teeth. The rubber bands also allow the orthodontist the ability to change the pressure exerted. As teeth move into place, new placements of rubber bands can be made to exert pressure on different teeth. The extra pressure from the rubber bands can cut the time a patient needs to wear appliances down by a third (roughly a year). Clinician using orthodontic elastics should know the forces applied to teeth at a given extension and how this force declines over a period of time. The objective of this study is to know the change in schedule of elastics as influenced by their force degradation.

Material and Methods

The characteristic decay of elastics was studied in an artificially simulated oral environment. All tested

elastics were received in sealed plastic bags from the manufacturer. Elastics from two different manufacturers, American orthodontics (Group I) and Dentarum (Group II) were used in this study. Elastics of medium weight and internal diameter of 1/4th of inch were selected. Three stainless steel jigs with ten sets of predetermined inter post distance of 14.8mm, 19.0 mm and 28.4 mm were fabricated to simulate 225% , 300% and 450% of stretching respectively. An instron universal testing machine (model no.4467) with 10kg load cell and cross head speed of 25mm per minute was used to measure the force in grams exerted by the elastics(**Fig .1**). Artificial saliva⁶ was prepared to simulate oral environment.

Incubator (GE Electronics) this was used in this study to regulate the temperature at 37 degree to simulate oral environment. Air sealed plastic bags are used to prevent moisture contamination during storage(**Fig.2**).

These sets were subjected to 225%, 300 % and 450% of stretching at various time intervals – i.e. initial, 24 hours and after 48 hours of incubation at 37 degree in artificial saliva. The forces were

recorded and tabulated. The initial forces of elastics were calculated using Instron universal testing machine. The amount of force exerted for 225%, 300% and 450% stretching were noted.

The same elastics were engaged on to the post of the stainless steel jig which expanded the internal diameter of the elastics by 225%, 300% and 450%. The stainless steel jigs were immersed in artificial saliva completely and incubated at 37 degree for 24 hours, to simulate oral environment.

After 24 hours of incubation these elastics were taken on to the Instron machine and the amount of force degradation was calculated and tabulated for 225%, 300 % and 450% of elongation. Later the same procedure was repeated after 24 hours totaling to 48 hours of incubation with the same elastics and the force degradation was calculated and tabulated in grams by similar method.

Results

The data was analyzed statistically using ANOVA and results were tabulated (**Table.1, Table.2**)

Discussion

This study was conducted on ninety elastic samples. The test samples were divided into groups and subgroups as follows to facilitate the test procedure.

GROUP I – American orthodontics

Group I samples were again sub divided into group Ia, Ib, Ic, Id and Ie each comprising of three elastics from different batches of the same manufacturer.

GROUP II – Dentarum

Group II samples were again sub divided into group IIa, IIb, IIc, IId and IIe each comprising of three elastics from different batches of the same manufacturer.

The force values for one hundred and eighty elastics at various time intervals i.e. initial, 24 hours and after 48hours and different percentage of stretching i.e. 225%, 300% and 450% were calculated and tabulated (**Table 3**).

Group I samples at 225% of stretching showed mean value of 120.07+/-0.33 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 85.00+/-1 gram and 75.67+/-1.15 grams respectively.

Force degradation of 29.20% was observed between initial and 24 hours of stretching and an additional 7.77% of force decay was observed after next 24 hours of incubation.

Group I samples at 300% of stretching showed mean value of 131.84+/-0.59 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 90.00+/-1 gram and 81.67+/- 1.53 grams respectively. Force degradation of 31.74% was observed between initial and 24 hours of stretching and an additional 6.31% of force decay was observed after next 24 hours.

Group I samples at 450% of stretching showed mean value of 177.73+/-1.56 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 111.00+/-1 grams and 88.33+/-1.53 grams respectively.

Force degradation of 38.11% was observed between initial and 24 hours of stretching and an additional 12.19% of force decay was observed after next 24 hours.

Group II samples at 225% of stretching showed mean value of 128.85+/- 2.43 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 92.00+/-1 gram and 82.67+/- 2.52 grams respectively. Force degradation of 28.59% was observed between initial and 24 hours of stretching and an additional 7.25% of force decay was observed after next 24 hours.

Group II samples at 300% of stretching showed mean value of 139.97+/- 0.41 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 97.00+/-1 gram and 88.67+/- 2.00 grams respectively. Force degradation of 30.69% was observed between initial and 24 hours of stretching and an additional 6.44% of force decay was observed after next 24 hours.

Table 1. Depicting the percentage of force decay of test group samples of different percentages of stretching and time intervals.

Stretching percentage	initial	24 hours	48hours	Significance by ANOVA	% change at 24 hrs	% change at 8hrs	Difference in percentage
Force in grams at 225% of stretching (mean ± SD)							
225%	124.46 ± 5.05	88.50 ± 3.94	76.67 ± 6.80	F= 127.81 (P<0.001)	28.89	35.98	7.09
Force in grams at 300 % of stretching (mean ± SD)							
300%	135.90 ± 4.47	93.50 ± 3.94	84.83 ± 3.82	F= 168.42 (P<0.001)	31.19	37.58	6.39
Force in grams at 450 % of stretching (mean ± SD)							
450%	180.81 ± 4.42	115.17 ± 4.62	92.16 ± 4.76	F= 501.941 (P<0.001)	36.30	49.02	12.72

Table 2. Depicting the mean force values among elastics from the two different manufacturers

GROUPS (MEAN)	225 %			300 %			450%		
	After 24 hours	After 48 hours	Difference of force decay from 24 to 48 hours	After 24 hours	After 48 hours	Difference of force decay from 24 to 48 hours	After 24 hours	After 48 hours	Difference of force decay from 24 to 48 hours
Group I American orthodontics	29.20	36.97	7.77	31.74	38.05	6.31	38.11	50.30	12.19
Group II Dentarum	28.59	35.84	7.25	30.69	37.13	6.44	35.11	47.79	12.68

Table 3 . Depicting mean force values in grams for test samples at different percentage of stretching time intervals

Groups (mean)	225%				300 %				450%			
	Initial	24 Hrs	48 Hrs	ANOVA	Initial	24 Hrs	48 Hrs	ANOVA	Initial	24 Hrs	48 Hrs	ANOVA
Group I LATEX American Orthodontics	120.07 ± 0.33	85.0 ± 1.00	75.67 ± 1.15	F=1370.77 (P<0.001)	131.84 ± 0.59	90.00 ± 1.00	81.67 ± 1.53	F=1766.70 (P<0.001)	177.73 ± 1.56	111.00 ± 1.00	88.33 ± 1.53	F=2840.41 (P<0.001)
Group II latex Dentarum	128.85 ± 2.43	92.00 ± 1.00	82.67 ± 2.52	F=352.121 (P<0.001)	139.97 ± 0.41	97.00 ± 1.00	88.00 ± 2.00	F=1344.20 (P<0.001)	183.90 ± 4.21	119.33 ± 0.58	96.00 ± 1.52	F=635.19 (P<0.001)



Fig.1. Instron universal testing machine

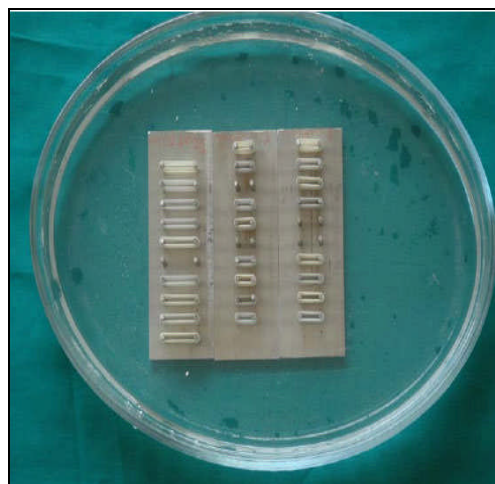


Fig.2. Air sealed bags

Group II samples at 450% of stretching showed mean value of 183.90 \pm 4.21 grams of force initially. After incubating for 24 hours and 48 hours at 37° C in artificial saliva they showed mean values of 119.33 \pm 0.58 grams and 96.00 \pm 1.52 grams respectively. Force degradation of 35.11% was observed between initial and 24 hours of stretching and an additional 12.68% of force decay was observed after next 24 hours.

Discussion

The use of orthodontic elastics has been recorded since 18th century. The elastics are successful over other tools used to deliver orthodontic force because of their ability to exert continuous force, convenience of use, cost effectiveness and their compatibility in oral environment are few of the many factors that has swung in favor of elastics. Resiliency of elastic products has been exploited to form force delivery systems in orthodontics. However, as with all objects living and non living, elastics do succumb to the laws of nature. The force levels decrease with respect to the initial forces exerted. This property is termed as the force decay maintaining optimum force is the key to successful orthodontic therapy so the force decay should be minimal and within acceptable limits. To apply an ideal orthodontic force an elastomeric needs to maintain the appropriate force. However conventional elastomers

exhibit a higher degree of irreversible force decay and are affected by oral environmental factors. Although there have been a number of studies concerning dental elastomers and the degradation of strength with time, varying results have been reported. This inconsistency is the result of many different kinds of materials and experimental methods, making it difficult to compare the products.

Therefore in this experiment, products of same size were used and their physical properties were examined with standardized environments. The percentage of elastic expansion was done in order to simulate maximum (450%), moderate (300%) and minimum (225%) opening of the mouth and also 300% of stretching to compare the forces as claimed by the manufacturers. Experiments carried out in dry and simulated oral environments of 100% humid conditions reported no significant differences for the different conditions¹. Greater force decay was observed in wet condition than in dry condition for the same temperature. So present study was done in simulated oral environment, using artificial saliva and incubated at 37degree Celsius^{4,5,7}

Studies show 50 to 75% initial force decay after 24hours and additional 10% loss of force over three weeks of time. This is similar to my study where maximum force loss observed was 25% to 35% after 24 hours and additional 10% of force decay was observed after 48hours^{2,3,5,6}

The amount of force decay in 450% of stretching was more when compared to 300% and 225% of stretching.^{1,3,7,8,9} The amount of force decay in 450% of stretching was more when compared to 300% and 225%. This can be attributed to the fact that elastics which were expanded more had exposed surface area in the artificial saliva and the degradation was more. Additional factors such as temperature changes, alkalinity of saliva and bacteria can infiltrate the weak molecular structure on the rubber surface resulting in discoloration and expansion. The $P < 0.001$ shows significant difference statistically.

Since the force degradation is too high in the initial 24 hours and subsequently, minimal during the next 24 hours, it is recommended to continue the elastic wear after the first day as the force decay is not much significant. But, though the degradation is too high in the first 24 hours the schedule of change of elastic wear recommended should be on a daily basis at an interval of 24 hours to maintain the force value closer to the product specification prescribed by the manufacturer. The $p < 0.001$ shows significant difference statistically when force decay at 24 hours and 48 hours of stretching were compared.

Although this study was undertaken in a stimulated oral environment and tested using universal testing machine its comparison to actual oral environment would be futile. This is because the actual oral environment is subjected to many more stimuli like dietary components, thermal variations and mechanical stresses. This study was done at constant static stretch of the elastics up to 225%, 300% and 450% whereas in actual clinical situation intermaxillary elastics are subjected to a cyclic stretch during various mandibular movements. Thus the scope for similar studies carried out in vivo including the natural effects remains to be explored.

CONCLUSION:

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