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Characteristics of force decay between latex and non-latex elastics- An invivo study

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Introduction

"Force is the medicine in Orthodontics" Sheldon Friel. Force derived from various sources i.e Muscles, springs, magnets, screws, archwire loops, elastics, etc have been used since the beginning of orthodontics to correct malocclusions. The earliest mention that force can cause movement of teeth came in 25 B.C when Celsus advocated the use of finger pressure to move teeth. Since then search has been on for materials, which provide constant force over suitable periods of time and which are compatible in oral environment. Elastomers have been a reliable method of delivering force in fixed appliance therapy for quite some time. Early advocates of rubber elastics in orthodontics included Case, Baker and Angle.[1,2] Elastics and Elastomeric are routinely used as an active components of orthodontic therapy for many years. It is easy for the patient to change the elastics by themselves to maintain oral hygiene. Natural Rubber, probably used by the ancient Incan and mayan civilization was the first known elastomer. The majority of orthodontic elastics available in markets are latex elastics. Since the 1990s synthetic products have been offered on the market for latex- sensitive patients and are sold as non- latex elastics.[10] Since the early 1990s synthetic products have been offered on the market for latex- sensitive and are sold as non- latex elastics.[10,11]

The latex elastics have become integral part of orthodontics after being first discussed by Calvin. S. case in 1893 at the Columbia dental congress but the credit goes to Henry A. Baker for the use of these elastics in clinical practice to exert a class II intermaxillary forces

At present Orthodontic elastics are widely used by the clinician as it as the ability to correct both Antero posterior and vertical discrepencies. There are various factors which affects the performance of elastics are the manufacturing process, Size and type of elastics, latex and non-latex (synthetic), Elastics and Alastiks or elastomerics, the distance of stretch, Prestretching the elastics, duration of stretch and intraoral configuration of placements.[2]

As the incidence of latex allergic reactions increases, the use of non-latex products within the orthodontic specialty, as well as the assessment of the material properties of non-latex elastics, will become increasingly important clinically.[8] Naturally engendered latex elastics are mainly utilized in the Begg technique to distribute intramaxillary elastic forces while synthetic elastomeric materials in the form of chains find their highest implementation in edgewise mechanics. It has been discovered that elastics loose their initial force after they are used for oral activities such as mastication, speaking and after being exposed to various oral environments that include different salivary pH, oral temperature, foods and drinks.

Because of presence of allergens in latex elastics, reactions to latex carry with them a wide range of risk factors During early 90s, non-latex elastics have been made available for orthodontic use but the guidelines for the clinical application of latex elastics are not necessarily applied to non-latex elastics. For this reason, the properties of these materials need to be assessed experimentally.

This aim of this study is to evaluate and compare the force decay characteristics of Latex and non- latex elastics in intraoral environment.

The Objectives were

1 To access the force decay of one brand of Latex and non- latex orthodontic elastics.

2. To compare the force decay at different time interval between Latex and non-latex elastics.

Materials and Methods

Source of Data: The sample for the study was derived from subjects registered as patients at Thaimoogambigai dental college and hospital, Chennai. The sample includes 20 Subjects, 9 Male and 11 Female. The age group of 17-30 years of age were participated in this study.

Method of collection of data: A prospective controlled clinical trial with split mouth design/ prospective study of 20 subjects who were in the finishing stage of the treatment in rectangular or round ss wire finishing and detailing. Written consent was taken from them.

Inclusion Criteria

1. The subjects who had registered for the treatment were taken into the study. Total of 20 subjects (9 Males and 11 Females) were included in this study.
2. Class II div 1 malocclusion, Class II div 2 malocclusion and Class II div 1 subdivision with no extractions and who were in finishing stage of occlusion.
3. 19* 25 ss wire and in 0.016 ss finishing wire in 0.022 MBT slot prescription.
4. Mouth opening ranging 43 to 45mm.

Exclusion Criteria

1. Patients in initial level of treatment
2. Patients were excluded if using systemic medication or had oral pathology.

Methods

Samples of Latex and Non-latex, non- coloured Orthodontic elastics were obtained from G&H Orthodontics(n= 180). The elastics were reported as 4.5 oz and of medium force. According to the manufacturer 3/16 is the only size specific. All other dimensions are variable. They cut the width so that the elastic will provide this force value. The width and thickness varies,so that

the force can be achieved. If these did not vary then the force would have a wide variance. All elastics were recently manufactured, were stored in plastic covers provided by the manufacturers at room temperature and kept away from sunlight to prevent any deterioration.

The side selection for the use of each elastic material of Latex and Non- latex was randomized and sequential so that one patient would use latex on the right side and the other patient would use non- latex on the left side and so on.

The elastics were attached to canine and first molar hooks for the placement of the elastics. Impression were recorded and model were made. Vernier caliper were used to measure the distance between the canine and molar.The mean value of the distance between the hooks for the placement of the elastics was 25mm. The patients were instructed to use an intermaxillary elastics for 12, 24, 36 and 48 hours. They could only remove the elastics to eat or brush the teeth, replacing the same elastics then. Individuals are given elastic placer for the ease of placing elastics.

By the time of elastics removal, the patients were asked to report to the hospital and elastics were removed and immediately transferred to artificial saliva in a small tube and carried to the laboratory, each elastic was carefully transferred with a pair of tweezers and force decay were measured and then discarded.

Force decay were performed with a Universal testing Machine. Two acrylic blocks with hooks were made and were fixed on the upper and lower members of the testing machine for the measurement of force decay. The elastics were engaged on the hooks and extension force magnitudes of the elastics were recorded which was stretched at a distance of 25mm. All procedure were performed by the same operator.

Results

The initial force provided by both types of elastics was higher than that reported by the manufacturer as given in Table 1. The latex and non- latex elastics showed an initial force of 161±9.5gm and 174±9.8 gm respectively, while the manufacturer reports an initial force of 4.5 oz (127gm). The mean value of elastics are measured and taken as 25mm. At 12 hours of activation, force reduced to 132.7±11.3 gm in the latex elastics and 106±11.3 gm in the non- latex elastics. After 24 hours, the reduction in force decrease by 122± 14.8gm in Latex and 95.35 ± 13.1 gm in non- latex elastics. At 36 and 48 hours 113.9± 14.9gm, 110± 9.8 gm in latex and 110± 9.8 gm, 76.35 ± 11.57 gm in nonlatex elastics as given in Table 1

Table 1: Descriptive statistics

MATERIAL	0 hour	12 hours	24 hours	36 hours	48 hours
Latex elastics	161.4±9.5	132.7±11.3	122±14.8	113.9±14.9	110±9.8
Non latex elastics	174±9.8	106±11.75	95.35±13.1	90.9±17.2	76.35±11.57

The table shows mean and standard deviation of latex and non-latex elastics at 0^{th} hour, 12 hours, 24 hours 36 hours and 48 hours respectively.

Table 2: Intragroup comparison of latex and non-latex elastics using ANOVA

Material	0 hour	12 hours	24 hours	36 hours	48 hours	p value
Latex elastics	161.4±9.5	132.7±11.3	122±14.8	113.9±14.9	110±9.8	0.0012*
Non latex elastics	174±9.8	106±11.75	95.35±13.1	90.9±17.2	76.35±11.57	0.0014*

P value less than 0.05 is considered significant

Intragroup comparison of latex elastics and non-latex elastics was done using ANOVA.

The mean force of Latex elastics at 0 hour was 161.4±9., 12 hours was 132.7±11.3, 24 hours was 122±14.8, 36 hours was 113.9±14.9 and 48 hours was 110±9.8.

The mean force of Non - Latex elastics at 0 hour was 174±9.8, 12 hours was 106±11.75, 24 hours was 95.35±13.1, 36 hours was 90.9±17.2 and 48 hours was 76.35±11.57.

Comparison showed differences at 0 hour, 12 hours, 24 hours, 36 hours and 48 hours with clinical significance (p-0.0012 & p-0.0014).

Table 3: Intergroup comparison of latex and non-latex elastics using independent t test

Hours	Latex elastics	Non latex elastics	P – value
0 hour	161.4±9.5	174±9.8	0.001*
12 hours	132.7±11.3	106±11.75	0.002*
24 hours	122±14.8	95.35±13.1	0.013*
36 hours	113.9±14.9	90.9±17.2	0.001*
48 hours	110±9.8	76.35±11.57	0.001*

p value less than 0.05 is considered significant

Intergroup comparison of latex and non-latex elastics was done using independent t test. Results showed significant difference at 0 hour, 12 hours, 24 hours, 36 hours & 48 hours with clinical significance (0.001, 0.002, 0.013, 0.001 & 0.001).

Table 4: Multiple comparison of latex elastics using Tukey's post hoc test

Dependent Variable		Tukey HSD Q statistic	Tukey HSD p value
0 hours	12 hours	9.7155	0.0001*
	24 hours	13.2700	0.0001*
	36 hours	16.0797	0.0001*
	48 hours	19.2989	0.0001*
12 hours	0 hours	9.7155	0.0001*
	24 hours	3.5545	0.0600
	36 hours	6.3642	0.0001*
	48 hours	8.5126	0.0001*
24 hours	0 hours	13.2700	0.0001*
	12 hours	3.5545	0.0600
	36 hours	2.8097	0.2020
	48 hours	4.5663	0.0091*

36 hours	0 hours	16.0797	0.0001*
	12 hours	6.3642	0.001*
	24 hours	2.8097	0.2020
	48 hours	1.4441	0.7133
48 hours	0 hours	19.2989	0.0001*
	12 hours	8.5126	0.0001*
	24 hours	4.5663	0.0091*
	36 hours	1.4441	0.7133

Multiple comparison of latex elastics using Tukey's post hoc test showed statistically significant difference ($p< 0.001$) was observed between (0 hour and 12 hours), (0 hour and 24 hours), (0 hour and 36 hours), (0 hour and 48 hours), (12 hours and 36 hours), (12 hours and 48 hours) and (24 hours and 48 hours). However no statistically significant difference between (12 hours and 24 hours), (24 hours and 36 hours) and (36 hours and 48 hours) was observed.

Table 5: multiple comparison of non- latex elastics using Tukey's post hoc test

Dependent Variable		Tukey HSD Q statistic	Tukey HSD p value
0 hours	12 hours	23.3857	0.0001*
	24 hours	26.9979	0.0001*
	36 hours	28.5072	0.0001*
	48 hours	38.4952	0.0001*
12 hours	0 hours	23.3857	0.0001*
	24 hours	3.6121	0.6500
	36 hours	5.1215	0.0002*
	48 hours	4.1579	0.0220*
24 hours	0 hours	26.9979	0.0001*
	12 hours	3.6121	0.6500
	36 hours	1.5093	0.6802
	48 hours	7.4179	0.0001*
36 hours	0 hours	28.5072	0.0001*
	12 hours	5.1215	0.001*
	24 hours	1.5093	0.6802
	48 hours	5.0824	0.0317*
48 hours	0 hours	38.4952	0.0001*
	12 hours	4.1579	0.0220*
	24 hours	7.4179	0.0001*
	36 hours	5.0824	0.0317*

Multiple comparison of non- latex elastics using Tukey's post hoc test showed statistically significant difference ($p < 0.001$) was observed between (0 hour and 12 hours), (0 hour and 24 hours), (0 hour and 36 hours), (0 hour and 48 hours), (12 hours and 36 hours), (12 hours and 48 hours), (24 hours and 48 hours) and (36 hours and 48 hours). However no statistically significant difference between (12 hours and 24 hours) and (24 hours and 36 hours) was observed.

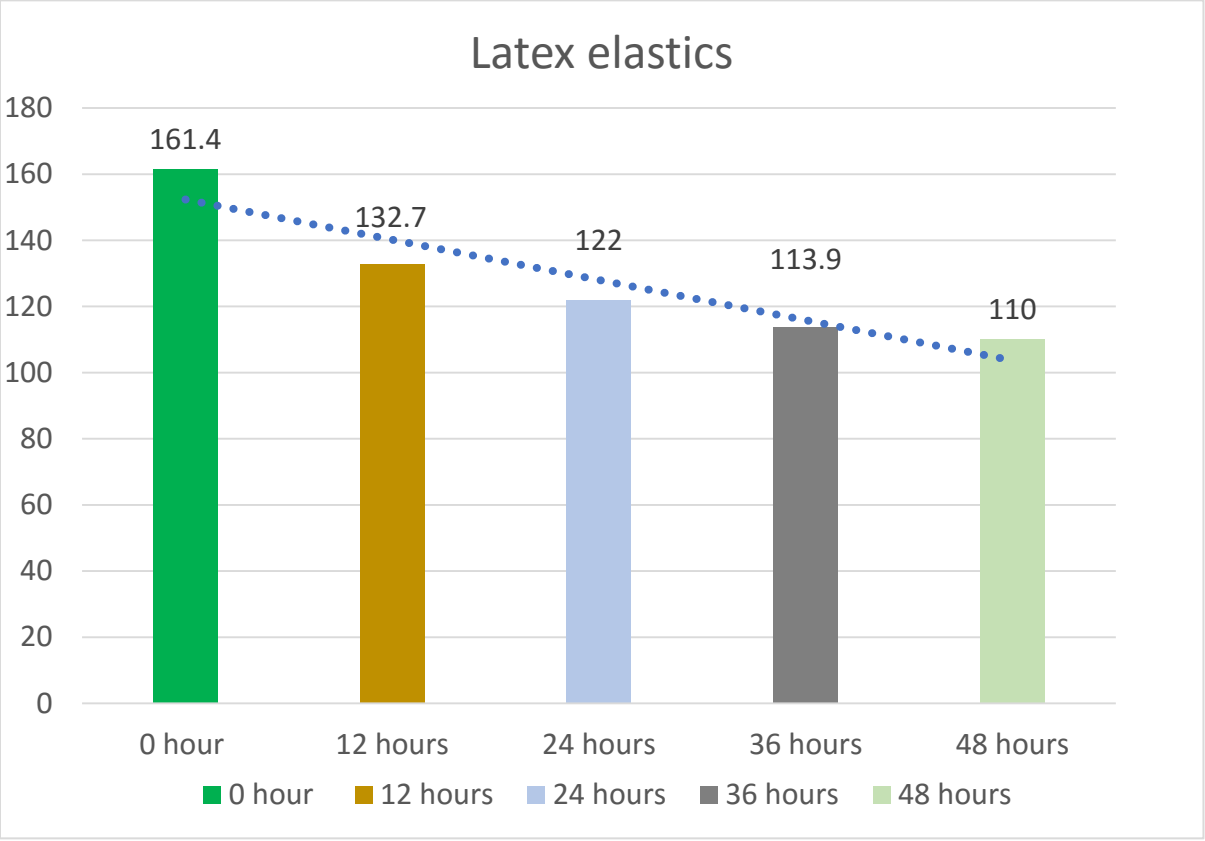

Figure 1: Graphical representation of latex elastics at various intervals (0 hour, 12, 24, 36, 48 hours) using bar graph

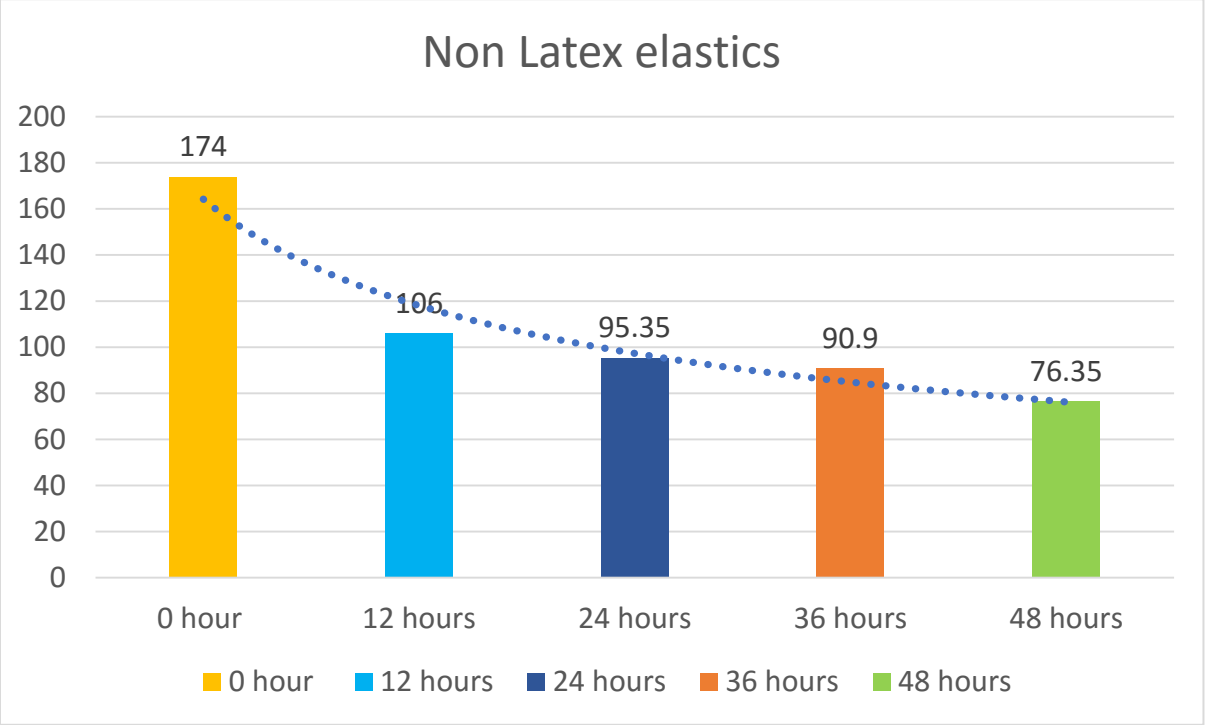

Figure 2: Graphical representation of Non latex elastics at various intervals (0 hour, 12, 24, 36, 48 hours) using bar graph

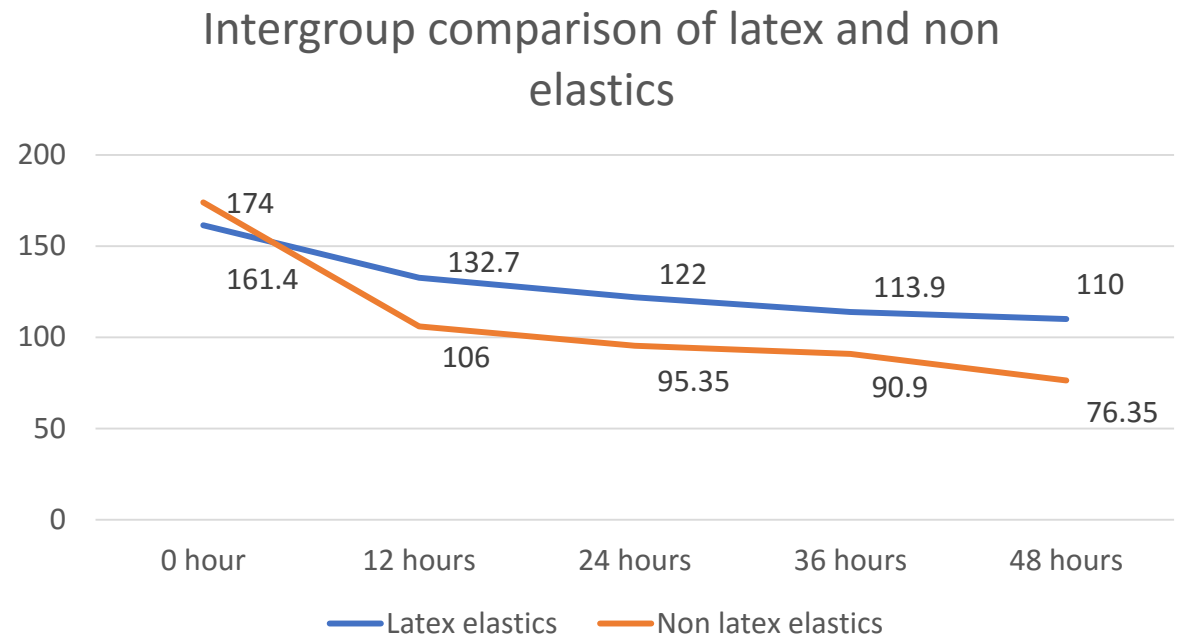

Figure 3: Graphical representation of Intergroup comparison between Latex and Non latex elastics at various intervals (0 hour, 12, 24, 36, 48 hours) using line diagram

Discussion

Force derived from various sources i.e. Muscles, springs, magnets, screws, arch wire loops, elastics, etc have been used since the beginning of orthodontics to correct malocclusions.

In orthodontics, elastics are available in latex and synthetic elastics i.e non-latex.

Latex elastics

These are made up of natural rubber materials obtained from plants, the chemical structure of natural rubber is 1,4 polyisoprene

Non-latex elastics

These are poly urethane rubber contains urethane linkage. This is synthesized by extending a polyester or polyether glycol or polyhydrocarbon with a di-isocynate. These are mainly used for elastic ligatures.

Reactions to latex materials have become more prevalent now and better recognized. Reactions to latex can be dermatological, respiratory or systemic reactions and in extreme cases, anaphylactic shock also. As the incidence of allergic reactions increase, the use of non-latex products within the orthodontic specially will also increase[5,10].

Elastics are used as an active components for orthodontic treatment such as retraction, cross bite corrections and space closure. Since Latex elastics can cause allergic reaction its contraindicated in patient with latex allergy. Inspite of the tissue irritation, latex elastics are mostly preferred and clinically used one[6,11].

Force degradation is a major quandary affecting the clinical utilization of latex or nonlatex elastics. Perpetual loss of tensile force over time makes it difficult for clinicians to determine the genuine force applied to the teeth, despite such applications being expected to engender constant and optimal tension for a designated duration.

A split mouth randomized study was performed with a limited sample size who were undergoing orthodontic treatment and were in the finishing stage of treatment were choosen. The sample size was taken as 20 for statistical interpretation. Moreover this sample size was suggested in some studies.

The materials used were latex and non latex elastics from one manufacturer. All elastics used in this study were recently manufactured, stored in plastic covers, provided by the manufacturer, at room temperature and kept away from sunlight to prevent any deterioration.

The force selected were medium and of 3/16 inch which delivers 4.5 oz of force as mentioned by the manufacturer. They cut the width so that the elastics will provide the force value. The width and thickness varies, so that the force can be achieved. If these did not vary then the force would have a wide variance. Since this study is mainly a comparison study of force decay between latex and non-latex elastics, different sizes of elastics were not considered.

In this study tests were conducted on a universal machine which has been frequently used for force measurement in various studies this machine was elected over the use of gauges for its reliability and accuracy.

The use of intermaxillary elastics mean distance ranging 25mm were measured for force decay. During the use of intermaxillary mechanics, the elastics underwent greater variation in its extension because of the movements of opening and closing of the mouth. Several studies observed that the normal interval of sagittal elastics of either Class II or III ranges from 20 to 50 mm during its clinical use.

The initial force exerted by the elastics of both latex and non-latex were both higher than that reported by the manufacturer. The latex and non-latex elastics showed an initial force of 161.4±9.5 and 174±9.8 respectively but the

manufacturer reports an initial force of 4.5oz. Our results coincide with the finding of other studies which also found for both latex and non-latex elastics.

The patient in the present study were given a proper instruction of using an elastics and to make easy for insertion, Elastic placer were given to each patient. After each interval of time patients were asked to visit the hospital. The elastics were collected and transferred to artificial saliva and carried to laboratory for the testing.

A study done by Pithon et al[9] evaluated the force decay of latex and non – latex invitro where he measured the force at 0,1,4,8,12 and 24 hours in which latex and nonlatex elastics 1/8, 1/4, and 5/16 inches in diameter were placed intermaxillary and observed at 0, 12, and 24 hours for stretching. Pithon et al[9] reported that non latex elastics 1/4 and 5/16 inches in size were able to maintain initial force for between 0 and 12 hours, implying the changes in the tensile force of the elastics Conflicting results were found by Russel et al[6] showing greater force degradation for nonlatex elastics than latex elastics. These differences may due to the different brands of elastics used, methods, and research environments of the studies are relatively small for the time period. By analyzing the rate of force degradation in the present study at the end of the experiment in relation to the initial assessment there was a significant difference between latex and non-latex elastics.

There was a wide range of force decay occurred in initial 12hours of time between latex and non latex elastics in which non latex elastics showed a greater force loss compare to non- latex elastics. Study done by Notaroberto et al[10] where elastic force was measured at 0,1,3,12 and 24 hours considering the fact that laboratory studies indicates the greatest force drop occurring in the first hours found that the biggest drop observed in first hour and there were continuous decrease of force during the 24 hours time. The non-latex elastics in their studies also demonstrated a significant large decrease in the amount of force generated between 0 and 1 hour, but continue to show significant loss of force within 3 to 12 hours and within 12 to 24 hours. Similarly, Russel et al[6] evaluated the force loss from 1hour to 24 hours duration and found that there were no consistent similarities between the GAC and Masal latex with GAC and Masal non latex.

In the present study, non latex elastics showed a greater loss in initial 12 hours and continuously showed a significant difference when compared to latex elastics in 24, 36 and 48 hours. Kersey ML[5] reported that the difference in percentage of force decay decreased from initial to 24 hrs period was 15.6% in non latex elastics groups and 8.2% for the latex elastics.

In this study when the latex elastics force decay was compared between the time interval it was analysed that there is a statistically significant difference was observed between 0, 12,24,36,48 hours however no statistics difference between 12hours and 24hours,24 and 36 hours as well as 36 hours and 48 hours. Similarly with Non-latex elastics. Pithon M.M et al[9] did a clinical study of 1/8",1/4", and 5/16 inch Latex and non latex elastics . Pithon M.M et al[9] concluded that Elastics with or without latex of 1/8 inch showed a significant difference among themselves at different intervals while 1/4" and 5/16 inch elastics showed no significant difference in force at certain level period.

The present study reported the force degradation were highest in the first 12 hours of use of intermaxillary elastics irrespective of the type of elastics. All study reported that force decay with time. The maximum force decay was seen in first hour of testing and then, gradually, rate of force decay decreased over a period of 24 hours. The result of the study verified that both latex and non latex elastics have significant and progressive force reductions over 12 -24 hours period.

The present study compared the force decay of two different compositions of elastics. While majority of the study compared the force decay within 24 hours period. Our study compared the force decay even after 24 hours of period i.e at 36 and 48 hours of time.

In comparison between latex and non-latex elastics of G&H orthodontics the latex elastics were better in delivering force over a period of time the percentage of force degradation of latex and non-latex elastics at 0, 12 and 24 hours is almost in agreement given by Noteroberto et al[10] in their study the mild variation could be because of the different manufacturer used in their study

This study shows that clinically latex elastics are better in force delivery over a period of 48 hours Unlike other study where the force measured over 24 hours. The non-latex elastics lost more force than latex elastics at all interval. If non-latex elastics were to be used it should be frequently changed in situation where patient is allergic to latex. Clinically the initial force generated will be used for overcoming frictional forces of the wire on the bracket, so the force which is applied on loading is not completely transferred on the tooth. The orthodontist should use measuring instruments to verify that the elastics are producing the expected level of force, and replace elastics several times a day, if necessary, to maintain higher constant forces during treatment, as recommended by Alavi et al[11].

However this study has some limitations in sample size .Further study should be performed as the result to be more accurate for representing a more reliable clinical condition

Conclusion

Based on the result obtained following conclusions were made The initial force given by latex and non- latex elastics was higher than that announced by the manufacturer.

The elastics showed a significant and progressive reductions in force throughout the experiment.

There was a significant force degradation observed in medium force 3/16 inch latex and non latex Orthodontic intermaxillary elastics between 0,12,24,36 and 48 hours ($p < 0.001$).

The most significant force degradation occurred in 12 hours both in latex and Non latex intermaxillary elastics.

Non latex intermaxillary elastics showed statistically significant amount of more force loss than the Latex elastics at all time interval.

Latex and Non latex elastics of 3/16 inch significantly differed among themselves at all evaluation period except (12 hours and 24 hours), (24 hours and 36 hours) and (36 hours and 48 hours).

Non latex can be used clinically but frequent changing of elastics is necessary as it tends to rupture soon.

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