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Original Article

# Comparison of the Force Released by Intermaxillary Elastics Used for Different Time Periods

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## ABSTRACT

**Objective:** The objective of the present study was to compare the strength degradation of the force of intermaxillary elastic used for different periods.

**Methods:** The sample included intermaxillary elastics used for 20 adult patients with bilateral Class II or III malocclusion in orthodontic treatment with fixed appliances, with a mean age of 27.25 years. Latex orthodontic elastics with 3/16 inch of diameter were used, with an average stretching of three times its diameter. The elastics were used in the same patient bilaterally for different periods, with each pair of elastics used for 1, 12, 24, and 48h. Thus, the sample consisted of 200 elastics, with 40 being used in each period (one pair used by each patient) and 40 new elastics without use tested as control. Elastics were tested using a universal testing machine, stretched with a velocity of 30 mm/min, and the force was evaluated in stretches of 15, 20, 25, and 30 mm. The degradation force was compared in the four different times of use and control by one-way ANOVA (analysis of variance) and Tukey tests.

**Results:** There were significant differences among the groups in all evaluated stretches (15, 20, 25, and 30 mm). The control elastics presented higher average forces numerically and statistically significant for all tested times, except for the elastic used for 1h. The elastics used for 1, 12, and 24h had similar forces among them, with a significant difference to the elastics used for 48h.

**Conclusion:** It is recommended to change the intermaxillary elastics after 24 h of use.

**Keywords:** Elastomers, materials testing, dental materials

## INTRODUCTION

The orthodontic literature reports the introduction of intermaxillary elastics after 1893 (1). This accessory was used to aid dental intercuspation to generate light and continuous forces in canine retraction, space closure, rotational correction, and anteroposterior correction of the malocclusions (2).

According to the material of manufacture, there are two types of orthodontic elastics: rubber or synthetic. Rubber or latex elastics are obtained from vegetable extraction (3). The synthetic, elastomeric, or plastic elastics are obtained by means of chemical transformations of coal, petroleum, and some vegetable alcohols (3, 4). Latex orthodontic elastics are widely used in orthodontics due to their low cost and great practicality (3).

The main characteristic of the elastics and determining their effectiveness is the elasticity, which is a property that is defined by the ability to return to the original dimensions, after suffering a substantial deformation (5). Elasticity is determined by the geometric pattern and by the type of existing molecular traction (5).

Most of the orthodontic devices used to exert forces and consequently to move teeth do not present a constant force (6). Over time, the magnitude of force initially employed is reduced and, with this, the tooth movement may decrease or cease. Elastic materials exhibit this characteristic, which is called the degradation of force (5, 7-9).

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Little is known about the strength degradation properties of the elastics after the use in vivo in orthodontic mechanics with intermaxillary elastics since few studies have been performed after the use in patients (10).

Therefore, it was decided to evaluate the elastics under dynamic conditions in vivo for verification of the degradation of force over a period of time due to the conflicting results in the literature regarding the elastic exchange time and because the methodology of most of the articles did not evaluate the behavior of the elastics after the use in patients. The aim of the present study was to evaluate the strength degradation of intermaxillary elastics used by patients in different periods to establish the clinical parameters regarding the frequency of exchange that should be used in orthodontic treatment.

## METHODS

The present study was approved by the Research Ethics Committee of UNINGÁ University Center, Maringá, Brazil. Written informed consent was obtained from the patients who participated in this study.

The sample included intermaxillary elastics used by adult patients with the following criteria:

- aged >16 years,
- presence of permanent teeth to erupted first molars,
- without dental anomalies of number and shape,
- Class II or III bilateral malocclusion in orthodontic treatment with fixed appliances and requiring the use of Class II or III intermaxillary elastics.

Thus, the elastics were used by 20 patients. The mean age of the patients was 27.25 (d.p.=9.53, minimum 16 and maximum 42) years. The study was composed of 2 male and 18 female patients. Of the 20 patients, 17 had Class II malocclusion, and 3 had Class III malocclusion, both bilaterally, using Class II and III intermaxillary elastics, respectively. Cases of subdivision were excluded from the study. The sample consisted of intermaxillary elastics used by these patients, coming from the dental clinic of one of the authors in the city of Maringá, Brazil.

Latex orthodontic elastics were classified as strength generators of medium intensity (130 g) according to the manufacturer (Dental Morelli Ltda, Morelli-Sorocaba, SP, Brazil) with a diameter of 3/16 inch (ref 60.01.311, lot 1930589).

The elastics were selected in pairs in plastic packaging and used by the same patient bilaterally for different periods, 1, 12, 24, and 48 h and an average stretch of three times their diameter. The distance of the application point of the elastics varied from each patient (from the canine to the first molar). However, since each patient used the elastics in each time evaluated (1, 12, 24, and 48h), the distance between points was not important because it did not influence the results.

However, the forces were not individually measured with the mentioned stretching, ranging from 150 to 200 g. Replacement reserves have been provided in case of loss. The patients used the elastics in their normal day-to-day routine, removing them to feed and brush their teeth.

After use, they were kept in a closed and thermal recipient to minimize the effects of storage. They were then tested for no >2 weeks after the use by patients.

In this way, the sample consisted of 200 elastics, 40 of which were used in each of the four periods (one pair for each patient), totaling 160 plus 40 new as the control group.

All tests were performed at the Experimental Dentistry Laboratory of the UNINGÁ University Center, Maringá, Brazil.

The force released by the elastics used at different times was tested using a universal testing machine, EMIC model DL500 (INSTRON), Claws GR001, coupled to a 50 kgf load chart and adaptation for distension of a C hook.



The elastics were individually taken to the hook of the machine with the aid of a bonding plier for brackets and stretched at a speed of 30 mm/min, and the force was evaluated in the stretches of 15, 20, 25, and 30 mm (Figure 1).

The results observed after the traction of the elastics were recorded in gram force (gf) by the computer program Tesc version 3.04 (EMIC, São José dos Pinhais, Brazil). The duration of the trial of each specimen was approximately 1 min.

### Statistical Analysis

The Kolmogorov-Smirnov test was used to verify data with normal distribution.

The strength of degradation of the elastics was compared in the four different times of use and control, without use, by the one-way ANOVA and Tukey tests. The tests were performed using Statistica software (Statistica for Windows, version 7; StatSoft, Tulsa, OK, USA). A p value <0.05 was considered significant.

## RESULTS

There was a significant difference among the times (groups) in all stretches evaluated (15, 20, 25, and 30 mm) (Table 1).

The control elastics presented higher mean strengths numerically and with a statistically significant difference for all the times tested, except for the elastics used for only 1h.

The elastics used for 1, 12, and 24h had similar forces between them, with a significant difference for the elastics used for 48h.

## DISCUSSION

Several mechanical studies were performed with the purpose of analyzing the properties of the intermaxillary elastics objecting

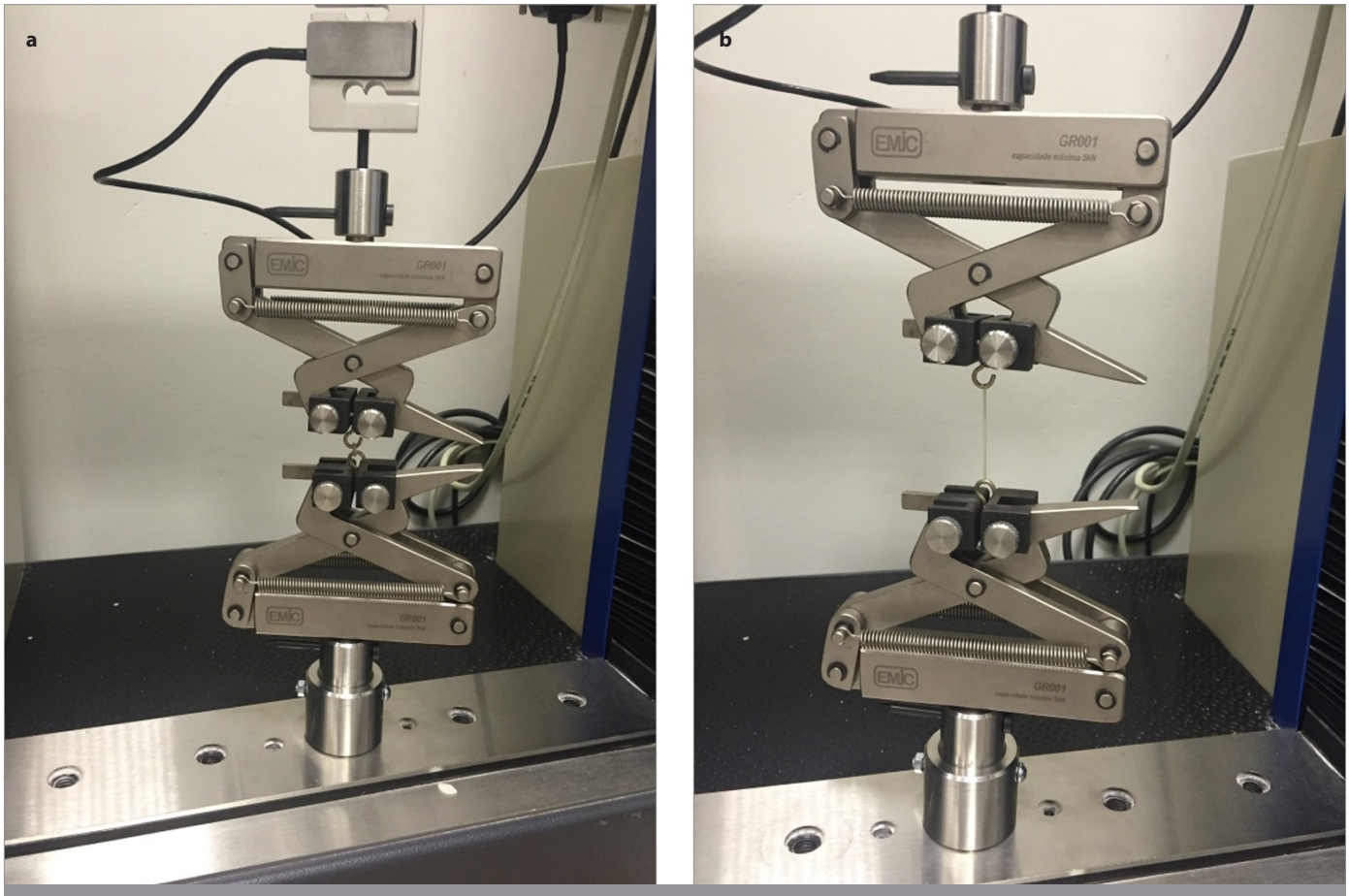


**Figure 1. a, b.** Stretch of the elastic for the test from 0 to 30mm



**Table 1.** Results of the elastic degradation force among the different times used and the control (one-way ANOVA and Tukey tests) (n=40)

| Degradation force (gf) | 1h Mean (SD) | 12h Mean (SD) | 24h Mean (SD) | 48h Mean (SD) | Control Mean (SD) | p |
|---|---|---|---|---|---|---|
| 15 mm | 155.45 (13.23) AC | 152.99 (9.80) A | 149.37 (13.27) A | 142.63 (13.55) B | 162.22 (6.79) C | 0.000* |
| 20 mm | 185.80 (15.46) AC | 183.90 (11.53) A | 178.84 (15.71) A | 170.95 (15.77) B | 194.17 (8.19) C | 0.000* |
| 25 mm | 216.75 (18.21) AC | 213.68 (13.95) A | 208.63 (18.35) A | 199.09 (18.28) B | 226.17 (9.83) C | 0.000* |
| 30 mm | 248.86 (20.99) AC | 247.11 (14.99) A | 239.82 (20.91) A | 228.89 (21.03) B | 259.38 (11.53) C | 0.000* |

*Statistically significant at $p<0.05$
Different letters in the same row indicate the presence of a statistically significant difference.
SD: standard deviation; gf: gram force; mm: millimeters

to find a behavior closer to the one occurring in the oral environment and its effects after its stretching at a certain distance and its analysis of the released force (6, 8, 11-16).

The present study was conducted on patients who needed the use of Class II and III elastics to conduct an analysis of the behavior of the elastics according to the reality and the time of use by the same patient and their stretching. The present results must be extrapolated with care, because it is a study, although clinical, transversal, and presents some limitations, as discussed below.

The versatility and practicality of the use of intermaxillary elastics become its main characteristic, with the 3/16 inch elastic the most used because of the distance of the stretch between the molar to the canine (6, 17). The professional must know the characteristics of elastics, their effects, advantages, and disadvantages to make an adequate planning and application (3, 18).

Intermaxillary elastics may help to correct Class II and III malocclusions and midline corrections. They can also be used for the extrusion of teeth, correction of crossbites, and intercuspation for finishing of orthodontic treatment, among others (3, 18). Therefore, the sample consisted of patients using Class II and III elastics.

The methods of analysis of the present study attempted to simulate the use of intermaxillary elastics in a real environment, being used by patients in their normal daily routine, removed in meals, and during teeth brushing. The tests were performed in a dynamic environment, and elastic tests and their strength

degradation were performed in different periods in the same patient. Other studies have tested the conditions of the orthodontic elastics in a static and dry environment or using cyclic tests for elastics, either latex or non-latex (6, 8, 19, 20).

The choice of patients aged >16 years was justified due to the concern with the fidelity of the sample of elastics and the responsibility of the patient to use them correctly, and adults tend to be more responsible and also to have all the teeth up to the first molar. The selection also included patients who had a history of good conduct and frequency in the clinic, as an attempt to obtain a reliable sample (5). The difference in sex distribution did not influence the results since compliance was not evaluated in the study. Consecutive patients who agreed to participate in the study were included in the study, and it appears that women are more likely to participate in the research. Some compliance and attention were necessary to use the elastics exactly as we ask for, and women appeared to be more cooperative.

As the test was performed in the same patient at all periods and the distance was the same, there were no factors that influenced the sample. According to Vilella (2), the force produced by the elastic is directly related to the distance between the hooks and the size of three times its distance (18, 21). A rigid standardization of the force applied and the distance of the points of support of the elastics was not necessary since it was the same for both time groups. For example, if a patient used the elastics stretched in 15 mm, with a force of 170 g, the same patient used elastics for the groups of 1, 12, 24, and 48h; the other patient with the elastics stretched in 18 mm with a force of 200 g also used elastics for all the groups evaluated. This way, this lack of rigid standardization did not influence the results.

The patient itself controlled the time that each elastic was used (1, 12, 24, or 48h). We intended to perform the study to represent the actual clinical situation of the use of intermaxillary elastics, and it represents the patient removing the elastics to feed and oral hygiene. This way, the time of use of 48h, for example, was not really the 48h literally, but 48h of use of elastics after their installation, considering the removal for meals and oral hygiene, reproducing the actual clinical situation.

In relation to the stretching studied, there was a decrease in strength in relation to the increase of stretches 15, 20, 25, and 30 mm throughout the sample including in the control group, corroborating with other studies (6, 9, 19, 20, 22-29). With the increase of the time of 0 (control group), 1, 12, 24, and 48h observed that the 3/16 inch elastic has greater significant force degradation after the 24h (10, 20, 26, 29, 30). Some authors obtained the same result, but others verified a loss of strength after 72h (6). According to Loriato et al. (3) with respect to the degradation of force, with the passage of time, the intensity of the force initially employed decreases.

However, Liu et al. (17) suggested that after the interval of 1 day, the decrease in the values of the forces stabilizes, assuming non-significant variation characteristics. For these authors, the stretch variable, due to the opening and closing of the mouth, does not imply cumulative influence on the material.

Authors, such as Bishara and Andreasen (13), Kanchana and Godfrey (14), and Wang (9), comment on the loss of strength after 24h consistent with our results. Beattie and Monaghan (30), Kumar et al. (26), and Fernandes et al. (19) found similar results of force loss with 1/4 inch elastics after 24 h. According to Oliveira et al. (20), there was also a larger drop of force after 24h.

Researches, such as by Liu et al. (17) and Bishara and Andreasen (13) comment on the choice and distance of elastic stretching between 20 and 50 mm. In other works, they were standardized to 30 mm, three times their size as Kersey et al. (31) but there is no standardization for this.

Wang (9) performed in vivo and in vitro research comparing the strength degradation of the elastics at time intervals of 24 and 48h showing similar results of force decrease in the range of 24-48h. Thus, this research suggests replacing 3/16 inch elastics every 24h along with several authors.

The control elastics presented the highest mean forces, similar to the elastics used for 1 h. This is a common point among all of the following authors (6, 9, 12, 14, 18, 19, 22-29, 31) that the degradation of force occurs over time, and that the force of the intensity initially employed decreases.



The elastics used for 1, 12, and 24h had similar forces between them, with a significant difference for the elastics used for 48h, which presented greater degradation in the means of forces. This result is similar to others (20, 26, 29, 30) who state that elastic forces decrease significantly after the first 24h of use, rendering the use for a longer period ineffective. Moris et al. (6) stated that the use for 3 days is recommended, but their study was reproduced in a simulated dynamic laboratory environment and in artificial saliva, which are not the actual conditions to which the elastics are exposed, so this will not be its expected performance when used in Class II or III malocclusion corrections.

## CONCLUSION

Control and 1h use elastics showed the highest mean forces. The elastics used for 1, 12, and 24h had similar forces between them, with a significant difference for the elastics used for 48h, which showed the smallest means of forces. Therefore, it is recommended to replace the intermaxillary elastics every 24h.

**Ethics Committee Approval:** Ethics committee approval was received for this study from the Ethics Committee of UNINGÁ University Center, Maringá, Brazil.

**Informed Consent:** Written informed consent was obtained from the patients who participated in this study.

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