orthodontic waves 69 (2010) 117–122

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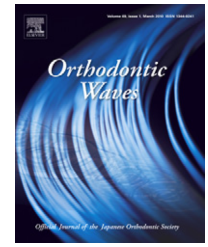

Research paper

The effect of static and dynamic testing on orthodontic latex and non-latex elastics

Ali S. Aljhani [a], *Abdullah M. Aldrees* [b,*]

[a] *King Abdullah International Medical Research Centre, King Saud University for Health Sciences, Riyadh, Saudi Arabia*
[b] *Department of Pediatric Dentistry and Orthodontics, College of Dentistry, King Saud University, P.O. Box 60169, Riyadh 11545, Saudi Arabia*

ARTICLE INFO

Article history:
Received 1 September 2009
Received in revised form
12 April 2010
Accepted 24 April 2010
Published on line 26 May 2010

Keywords:
Elastics
Latex
Non-Latex

ABSTRACT

The purpose of this study was to test the force decay properties of different kinds of orthodontic elastics after subjecting them to static and cyclic testing. Latex and non-latex elastics obtained from GAC, American Orthodontics and Ortho-Organizers were used in a sample size of 10 elastics per group. Static testing involved stretching the elastics three times the internal diameter, while in cyclic testing, the elastics were stretched up to 50 mm to simulate maximum mouth opening. Elastic forces generated were measured using the Instron testing machine and recorded in grams. Elastics on average lose 10% and 12% as a result of static test and 30% and 35% as result of cyclic test for latex and non-latex brands respectively, and most of the force loss occurs during the first half hour and after the first 10 cycles. This difference in force loss between latex and non-latex elastics could be due to the different structure and composition of the polymer involved. There are no significant differences between different groups of latex elastics in terms of force loss or even between the different groups of the non-latex elastics under static testing, however, under cycling testing differences between the groups were detected. Forces generated by the elastics are different from the manufacturers' labeled forces.

1. Introduction

Elastics have been used in orthodontics to move teeth for more than a century [1,2]. Orthodontic elastic are inexpensive, relatively hygienic and are easily applied. Elastics in the oral cavity absorb water and saliva, permanently stain and undergo both fatigue and creep [3]. They lose forces rapidly due to stress relaxation which leads to gradual loss of their effectiveness. The loss of force delivery and degradation of orthodontic elastics are major defects that affect clinical choice.

Andreason and Bishara found that in a period of 24 h, latex elastics lost 42% of initial force, and the greatest percent of force decay occurred during the first hour [4,5]. Kovatch and Keller found that rapid stretching produced greater initial forces compared to slow stretching [6], while Ash and Nikolai concluded that more force loss may occur due to the effect of mastication, oral hygiene, salivary enzymes and temperature variation within the mouth (*in vivo*) [7]. A similar pattern of force degradation in the wet environment was observed by Wang et al. *in vivo* [8]. Bertl et al. found a significant force loss generated by elastics within the first half an hour, which continued to decrease up to 8 h reading [9]. To achieve the

* Corresponding author. Tel.: +966 1 4676057; fax: +966 1 4679017.
E-mail address: amaldrees@ksu.edu.sa (A.M. Aldrees).
1344-0241/$ – see front matter
doi:10.1016/j.odw.2010.04.003

reported force of the latex elastics, an extension of 2.7 and five times the original length was found to be required by Gioka et al. [10].

Orthodontic elastics are not subjected to static stresses only when they are in the patient's mouth. They also undergo repeated stretching as the patient talks, eats, and yawns. Effects from these movements had not been investigated until 1993 when Liu et al. studied this elastic property. The authors found that cyclic stress will significantly lead to force loss. However, most of the effect occurs in the first 200 cycles [11].

Due to the recent increase in awareness of the health risks of latex products [12], several companies have started marketing synthetic non-latex elastics and are offered as an alternative to latex elastics. Russell et al. compared the mechanical properties of latex and non-latex orthodontic elastics [13]. They reported that after 24 h, the relationship between the different groups was significantly different [13]. In their study, Kersey et al. reported that the latex elastics lost 25% of their force after 24 h while the non-latex elastics lost nearly 50% of their force over 24 h, and they concluded that latex elastics are superior to non-latex elastics [14]. Kersey et al. also compared the effect of cyclic fatigue on force decay properties of four different brands of non-latex elastics [15]. The authors concluded that all elastics in the study are comparable in terms of their mechanical properties. The rapid loss of force of the orthodontic elastics due to static and cyclic stress relaxation, resulting in a gradual loss of effectiveness was a major drawback. Bertoncini et al. compared latex to non-latex elastics produced by a single manufacturer and they confirmed previous studies that reported that latex elastics undergo less loss of force than the non-latex elastics [16]. The same researchers has also investigated these two groups under cyclic testing, and concluded that the latex-free elastics must be replaced more frequently than conventional latex elastics [17].

The extensive body of literature regarding this property has been difficult to evaluate because of the different investigation methods and the different types of elastics available. The mechanical properties of the elastics varied considerably with the type of material and the manufacturer. Clinicians using orthodontic elastics need to know the forces applied to teeth at certain extensions and how these forces decline over time. The literature lacks a comparison between different types of latex and non-latex elastics supplied from different manufacturers with respect to static and cyclic stress. This study aimed to compare the force decay pattern of different latex and non-latex elastics from different manufacturers subjected to static and cyclic stresses. Also, another objective was to determine the differences from a single supplier and between different suppliers. Furthermore, to determine the accuracy of initial forces generated by different latex and non-latex elastics as stated on by the suppliers and determine the variation in force produced in each group (package).

2. Materials and methods

Orthodontic latex and non-latex elastics from three manufacturers were tested: GAC International (Islanda, NY) 6 mm (1/4 in.) 4 oz (113 g), American Orthodontics (Sheboygan, Wis.) 6 mm (1/4 in.) 4 1/2 oz (127 g), and Ortho-Organizers (San Marcos, Calif.) 6.4 mm (1/4 in.) 4 1/2 oz (127 g). All elastics were similar in terms of structure. Samples obtained were within their expiration dates and stored as recommended in sealed bags in a dark environment at room temperature.

2.1. *Testing apparatus*

An Instron testing machine (Model 4202, Instron Corporation, Canton, Mass.) with load cell capacity of 100 Newton was used. Elastics were stretched on the testing machine using two hooks made of 1.3 mm diameter stainless steel (Fig. 1a). The loads were recorded in Newton and then converted to grams. The load cell was calibrated before each data collection to confirm the validity of reading.

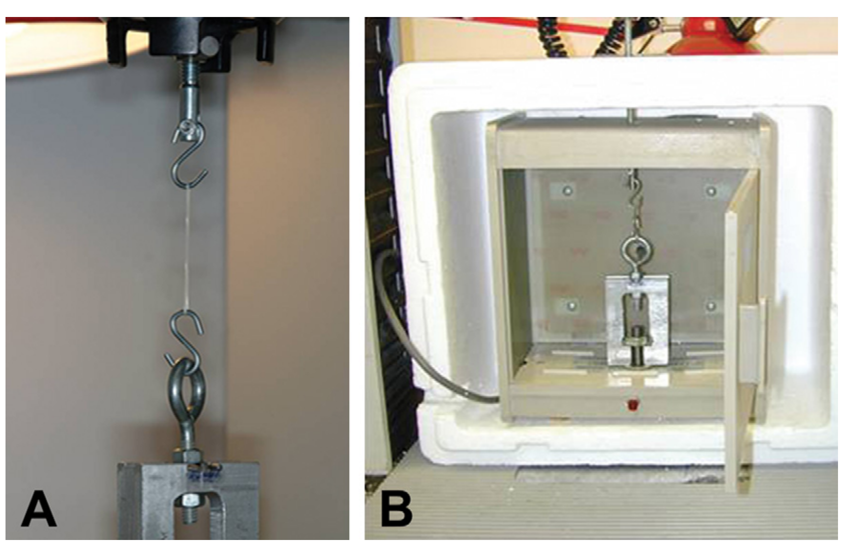

Fig. 1 – (a) Elastic stretched three times the internal diameter with the hooks attached to the Instron testing machine. (b) Elastic stretched in an environmental chamber.