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Influence of different disinfection processes on intra-arch latex elastic

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Abstract

Objective: The objective of this study was to evaluate the behavior of intra-arch latex elastic of different brands and colors when subjected to disinfection procedures.

Methods: A total of 320 units of American Orthodontics elastic; Morelli and Uniden were selected and divided into four groups according to the performed disinfection process: autoclave - 15 minutes; hypochlorite - 20 minutes; glutaraldehyde - 30 minutes and control. The disinfecting agents and the disinfection time were defined by a prior microbiological test. Before and after disinfection, by means of a universal trial machine, the maximum generated strength – until the rupture occurred – was evaluated.

Results: The autoclave disinfection reduced significantly the strength generated by elastic, in 75% of the brands. The disinfection in hypochlorite increased significantly the strength generated by Morelli elastic; probably the alteration to its elastic property increased its rigidity. Neither the Yellow Uniden nor the American elastic suffered any significant reduction in strength as the result of hypochlorite disinfection. The glutaraldehyde was the disinfectant solution with less significant effect on the strength of the bands, affecting only the Green Uniden.

Conclusion: The results suggest that the 2% glutaraldehyde is the disinfectant less aggressive to the elastic performance.

Key words: Latex; Orthodontics; Disinfection

Influência de diferentes processos de desinfecção no comportamento de elásticos intra-orais de látex

Resumo

Objetivo: O objetivo deste trabalho foi avaliar o comportamento dos elásticos intra-orais de látex de diferentes marcas e cores quando submetidos a realização de processos de desinfecção.

Métodos: Um total de 320 unidades de elásticos American Orthodontics; Morelli e Uniden foram selecionados e distribuídos em quatro grupos de acordo com o processo de desinfecção realizado: autoclave – 15 minutos; hipoclorito – 20 minutos; glutaraldeído – 30 minutos e controle. Os agentes desinfetantes e o tempo de desinfecção foram definidos por um ensaio microbiológico prévio. Foi avaliada a força máxima gerada até a ruptura por meio de uma máquina de ensaios universal antes e após a desinfecção.

Resultados: A desinfecção em autoclave reduziu de forma significativa a força gerada pelos elásticos em 75% das marcas. A desinfecção em hipoclorito aumentou de forma significativa a força gerada pelo elástico Morelli, provavelmente por alterar sua propriedade elástica aumentando sua rigidez. Apenas o Uniden Amarelo e o American não sofreram redução significativa da força em função da desinfecção em hipoclorito. O glutaraldeído foi a solução desinfetante com menor efeito significativo sobre a força dos elásticos, influenciando apenas o Uniden Verde.

Conclusões: Os resultados sugerem que o glutaraldeído 2% é o desinfetante menos agressivo ao desempenho elástico.

Palavras-chave: Látex; Ortodontia; Desinfecção

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Introduction

The intra-arch latex elastic is used during orthodontic treatments to help correction of the anteroposterior relationship, midline deviation and in maximal inter-cuspation [1]. It is produced from the extraction of natural rubber mixed with additives such as sulfur whose chemical reactions provide the desired properties to the material [2,3].

Its properties have been widely studied. According to Wong [2], this material presents as characteristic a significant reduction in strength after 24 hours. This way, as a material that requires daily replacement in order to make the desired motion, small quantities of it are provided to patients so that they can make the necessary changes [4].

During the manipulation process for the separation of the units into individual portions or for the storage of the product that is sold in larger packaging, or even in case of a non-use of total units by the patient, cross-contamination may occur.

The method of choice for disinfection of dental material is an autoclave. However, the literature shows that cycles greater than 20 minutes can alter its mechanical properties [5]. Nowadays, the 2% glutaraldehyde, the 1% hypochlorite and the 0.2% peracetic acid are the main disinfecting agents used in dentistry. These solutions have proven antimicrobial action in heat-sensitive materials such as acrylic resins, print materials and porcelain [6-9].

However, since the latex elastic is a polymer composed of units of isoprene that are extracted from plants, its chemical structure varies according to the type of plant, to the region where it is found and to the season in which it is extracted [2]. These characteristics may be influenced by the disinfecting agent, affecting not only the disinfecting effectiveness, but also the elastic properties of the material.

Therefore, the objective of this study was to evaluate the effect of different processes of disinfection on the elasticity of the latex plastic when submitted to traction.

Methods

In the first stage of this study, a microbiological trial was carried out assessing the contamination of material from the industry before any kind of manipulation. Then, the effectiveness of disinfection and the definition of the lowest times of disinfection were evaluated. The elastic bands were randomly assigned according to the type of disinfecting agent and to the time evaluated (Table 1). Initially, the samples were evaluated for their prior contamination; all samples showed lack of growth.

Table 1. Types of agents and time spent on disinfection

Disinfecting agent	Time (minutes)
2% glutaraldehyde	30
1% hypochlorite	20 and 60
autoclave	15
0.2% peracetic acid	5, 20 and 60

Then, new samples were selected and contaminated using strains of *Escherichia coli* 25922 American Type Culture Collection (ATCC), *Staphylococcus aureus* 25923 ATCC and *Candida albicans* 10231 ATCC. For contamination, the inocula were prepared in saline solution and were standardised in a spectrophotometer at 530 nm, with absorbance of 0.08-0.1, and later diluted in Brain Heart Infusion broth (BHI) until obtaining 10^4 CFU/mL [10]. The latex elastic bands were immersed in aliquots of this contaminated culture medium and incubated for 24 hours. After this period, they were washed with saline solution 0.89% for 5 minutes and subjected to the various disinfection processes.

After the disinfection processes, the elastic bands were, once again, immersed in saline solution for 5 minutes, followed by plating on BHI agar. The growth was assessed by counting Colony Forming Units (CFU). From the microbiological results, the disinfectants used and the lowest times spent for evaluation of the elasticity were defined.

For carrying out the tensile test, American Orthodontics® (Sheboygan, WI, USA), Morelli® (Sorocaba, SP, Brazil) and Uniden® (Sorocaba, SP, Brazil) intra-arch latex elastic bands, size 3/16" were selected.

In each trial 10 – natural colored units of each brand were selected, in addition to 10 units for each of the 5 colors produced by Uniden (purple, pink, green, coral and yellow), totalling 320 units divided into four groups according to the disinfection process conducted (autoclave – 15 minutes; hypochlorite – 20 minutes; glutaraldehyde – 30 minutes and control). The peracetic acid group was not included in the mechanical analysis because it was not effective at disinfecting elastic.

The elastic in the control group were removed from the packaging provided by the manufacturer at the time of the tests, the elastic in the autoclave group passed by a single cycle sterilization process for all units, the elastic bands in the hypochlorite and the glutaraldehyde groups were disinfected in separated receptacles according to the type of elastic.

All units were subjected to the tensile test by means of the EMIC DL 2000 (EMIC São José dos Pinhais, PR, Brazil) universal testing equipment, with the aid of a device formed by two "L" shaped rods constructed in stainless steel with circular section of 0.7 mm (Figure 1).

The elastic bands were fixed around the rods and stressed at a speed of 100 mm/s until their rupture. The maximum force (N) at this time was recorded by the computer connected to the equipment. The data were analyzed using the ANOVA one-way statistical tests and the Tukey multiple-comparison test, with a 95% significance level.

Results

Among the disinfection procedures evaluated, the only one that was not effective for the latex elastic was the 0.2% solution of peracetic acid, at all time points evaluated, whereas the treatments with sodium hypochlorite (20 and 60 minutes), glutaraldehyde and autoclave were effective for disinfecting rubber bands.

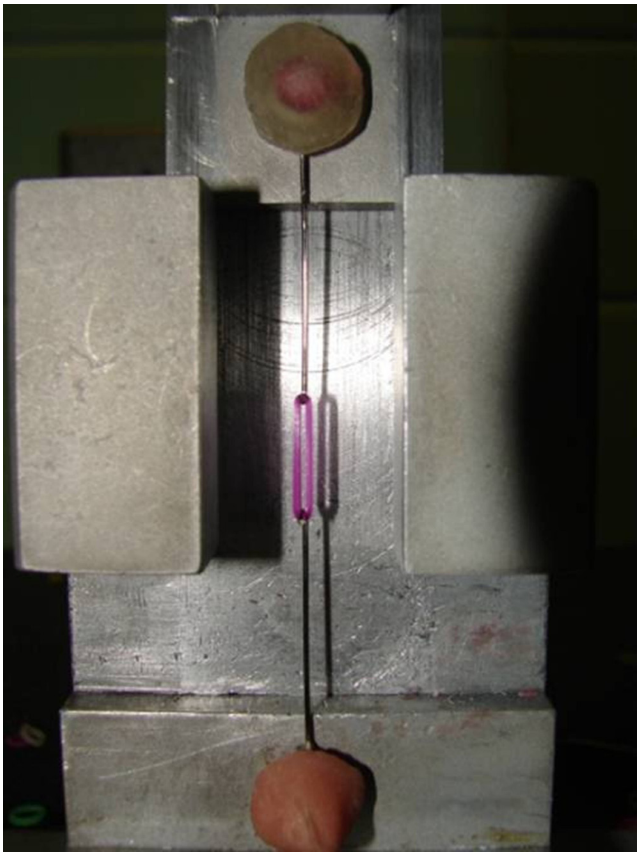

Fig. 1. Device for traction of plastic bands attached to the trial universal machine.

The results obtained in traction tests are described in Figure 2. Before disinfection procedures, the groups showed different values of strength. The control groups Morelli and Yellow Uniden showed significant difference of strength in relation to all the other control groups, while the Natural Uniden (NU) group showed significant difference among the Purple, Green and Coral Uniden groups.

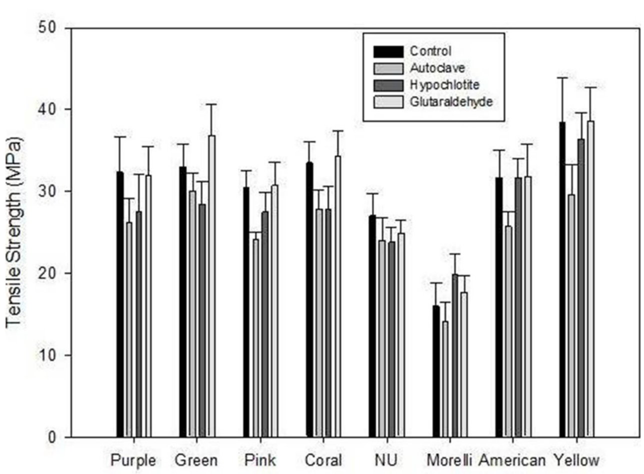

Fig. 2. Means and standard deviation of the strength generated by elastic in each disinfecting group.

The disinfection in autoclave reduced significantly the strength generated by the American, the Purple, the Pink, the Coral, the Yellow and the Natural Uniden elastic bands. The disinfection in hypochlorite significantly increased the strength generated by the Morelli elastic. Only the Yellow Uniden and the American elastic did not suffer a significant reduction in strength as the result of hypochlorite disinfection. The glutaraldehyde was the disinfecting solution with less significant effect on the rubber bands, influencing only the Green Uniden elastic.

Discussion

The latex elastic bands should be used in several stages along the orthodontic treatment, and their handling by the professional and his assistants can lead to cross-contamination. Therefore, the disinfection becomes a mandatory procedure. Different means have been tested in order to identify the method of disinfection with minor effects on the elastic property of the material.

The definition of immersion times was established from the microbiological trials, when the lowest times, enough for inhibiting microbial growth, were selected. From that definition, mechanical tests were made in order to evaluate the effects of these disinfecting agents in the elastic property of the material. All the solutions evaluated were effective in the process of disinfecting the latex elastic with the exception of the solution of 0.2% peracetic acid contradicting studies developed with other materials, in which the peracetic acid was effective in elastic disinfection [6,7].

As observed by Evangelist et al. [11], among the trademarks used which were not subject to the disinfection process (control group), significant differences of strength at the time of rupture were found. This can be attributed to small differences in the production process, and to the fact that the product comes from natural raw material presenting variations according to the region it is extracted [2]. In addition, the significant difference of the values of strength of the Natural Uniden elastic control group in relation to the colored bands of the same brand, with the exception of the pink elastic, may be related to the presence and types of additives used to promote the pigmentation of the elastic [12,13].

The autoclave reduced significantly the strength required to break the elastic band when subjected to traction in 75% of the groups analyzed. This may be the result of the influence of high temperature at which this material is submitted during the disinfection process [14]. According to Paige et al. [14] temperatures above 50°C reduce by 87% the required strength to pull the latex elastic.

Temperatures up to 20°C did not influence significantly the elastic property of the material, however are ineffective for disinfection [14]. The disinfection in glutaraldehyde presented the smallest significant influence in the strength under traction compared to different groups, even in relation to hypochlorite which requires a shorter time of immersion for disinfection.

This may be related to the difference between the pH of the two solutions, since the hypochlorite presents alkaline pH around 11 and the glutaraldehyde presents acid pH, around 4 [15]. In their study, Sauget et al. [16] found a non-significant relationship between reduction in the strength in different tested times and the increase in the pH.

However, the authors above used pH values of 5 and 7.5, differently from the ones used along this work in which the variation between the pH of glutaraldehyde and of hypochlorite solutions was wider, and this may intensify this difference of reduction in strength [16].

Conclusion

The results found in this study suggest that the 2% glutaraldehyde is the less aggressive disinfectant to the elastic performance.

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