

The acrylic's design or the addition of internal orthodontic wire changes the resistance of orthodontic plates?

O desenho do acrílico ou a adição de fio ortodôntico no seu interior altera a resistência das placas ortodônticas?

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Resumo

Objetivo: Avaliar a resistência de placas de contenção tipo Hawley em três diferentes configurações do acrílico, a fim de se avaliar se o formato deste ou a adição de fio no seu interior interfere na sua resistência. **Material e método:** Foram confeccionadas 45 placas de contenção móveis tipo Hawley, divididas em três grupos (n=15): Grupo 1 – acrílico recobrimdo todo o palato duro; Grupo 2 - placa com alívio na região mais profunda do palato, deixando-a com uma conformação em “U” e Grupo 3 – similar as do Grupo 2, com a adição de fio 0.7mm de 2cm no interior do acrílico na região da rugosidade palatina. A resistência à compressão foi testada em uma máquina universal de ensaios mecânicos (Stable Microsystems, London, United Kingdom), medindo-se a força aplicada até que ocorresse a ruptura da placa. **Resultado:** o Grupo 1 foi o que apresentou maior resistência, com uma mediana cerca de cinco vezes maior que o Grupo 2 e três vezes maior que o Grupo 3. **Conclusão:** a redução do acrílico nas placas de contenção está diretamente relacionada com a redução em sua resistência à compressão; a inclusão do fio ortodôntico no interior do acrílico aumenta a resistência da placa, sendo uma boa alternativa quando se deseja maior conforto ao paciente sem que haja detrimento das características mecânicas dos aparelhos de contenção.

Descritores: Desenho de aparelho ortodôntico; ortodontia; má oclusão.

Abstract

Objective: Evaluate resistance of Hawley retainers in three different acrylic configurations in order to evaluate if its format or the addition of internal wire interferes in its resistance. **Material and method:** 45 Hawley retainers were fabricated, divided into three groups (n = 15): Group 1 - acrylic covering the entire hard palate, Group 2 - plate with relief at the deepest region of the palate, leaving it with a “U” conformation and Group 3 – similar to Group 2, with the addition of 0.7mm wire 2cm internally of the acrylic at the region of the palatine ridges. The compressive strength was tested in a universal mechanical testing machine (Stable Microsystems, London, United Kingdom), measuring the applied force until plate rupture occurred. The differences between the formats being compared by the Kruskal-Wallis test. The significance level was set at 5% ($\alpha = 0.05$). **Result:** Group 1 showed the highest resistance, with a mean of about five times higher than Group 2 and three times higher than Group 3. **Conclusion:** acrylic reduction in dental retainer plates is directly related to the reduction of its compressive strength, the inclusion of orthodontic wire inside the acrylic increases the resistance of the plate, being a good alternative when more comfort is wanted for the patient without loss of the mechanical characteristics of the dental retainers.

Descriptors: Orthodontic appliance design; orthodontics; malocclusion.

INTRODUCTION

At the end of the orthodontic treatment it is necessary to hold the teeth in the correct position until the complete adaptation of the stomatognathic system^{1,2}. Among the container apparatus described in literature and widely used, there are the fixed and the removable ones, and among these last ones, the Hawley retainer, in its various configurations, is the most widespread^{3,4}. This retainer consists basically of an acrylic plate and a labial arch, surrounding the teeth, made of steel wire braces^{5,6}.

Literature describes various types of modifications of these devices aiming to improve their performance, such as labial arch made of clear plastic material,^{5,7-11} providing improved aesthetics and palatine covering for the cases where there was initially exaggerated overbite¹⁰.

Another quite frequent change nowadays is the modification of the acrylic, leaving it with a “U” form and providing better accommodation for the tongue. However, what would be the

losses, from the point of view of resistance, when reducing the palate acrylic of these devices? Empirically, when these appliances are made, an orthodontic wire is added within the acrylic to improve its resistance.

Because of the complete lack of studies evaluating these criteria, the proposal of the authors of this survey was to evaluate the resistance of Hawley retainer plates with three different acrylic configurations.

MATERIAL AND METHOD

To perform this experiment, 45 removable Hawley retainers were made. The retainers were divided into three groups (n = 15) according to the acrylic format and the addition of internal orthodontic wire: Group 1 - acrylic covering the entire hard palate, Group 2 - plate with relief at the deepest region of the palate, leaving it with a "U" conformation and Group 3 - similar to the second group but with the addition of 0.7mm wire 2cm internally of the acrylic at the region of the palatine ridges (Figure 1).

All devices were fabricated by the same operator using a single orthodontic model. Dental wax (Orthocentral, São Carlos, Brazil) sheets 2mm thick were adapted for the standardization of the inserted acrylic resin limits.

This barrier was set at the boundary between soft and hard palate, at the region close to the teeth, leaving only the cervical exposed (Group 1) and also at the central region of the hard palate for the confection of the retainers with the "U" form (Groups 2 and 3). After producing the models, 45 vestibular fasteners were folded using 0.7 mm wire, to surround the teeth's vestibular face (Figure 2).

After isolation of the plaster models with gypsum insulator (Cell Lac, São Paulo, Brazil), the clamps were fixed with utility wax (Orthocentral, São Carlos, Brazil). Subsequently, acrylation was begun using autopolymerizable acrylic resin (Jet, São Paulo, Brazil) using the technique of incrementally adding the polymer to the monomer (Powder and Liquid). Once the acrylic inserted, the plates were placed in a pressure cooker at a pressure of 25 lbs to eliminate bubbles. After 25 minutes under pressure, the plates were removed from the water and the thickness of the acrylic was

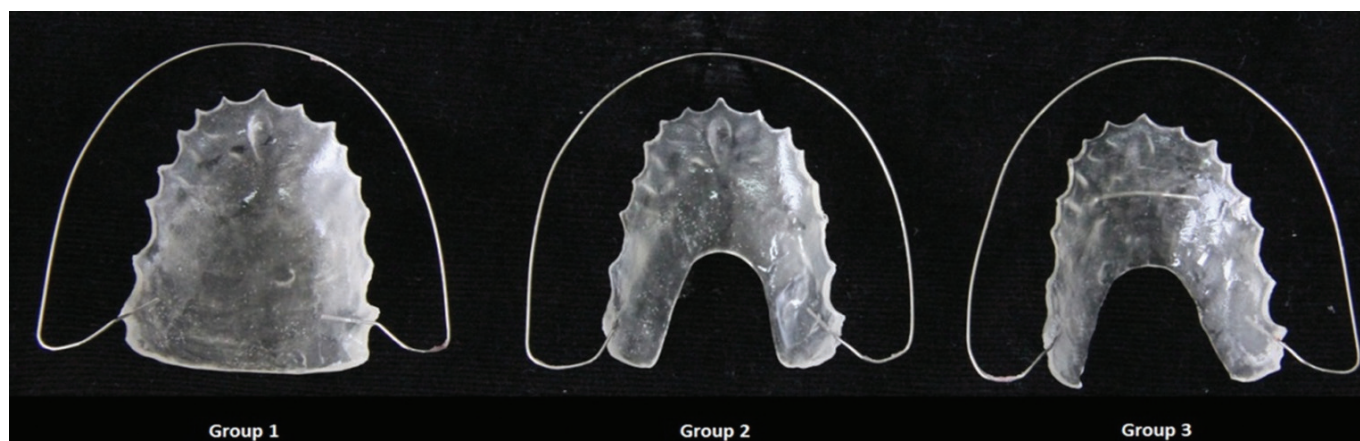


Figure 1. Retainers evaluated.



Figure 2. a- Wax barrier used for the acrylation of the first group; b- wax barrier with relief at the central region of the palate, for the acrylation of groups 2 and 3.

measured with the aid of a gauge caliper (Golgran, São Paulo, Brazil).

After fabrication of the plates, the stage of completion began and possible excesses were removed with the use of a dental bur (Edenta AG, Hauptstrasse, Switzerland) attached to a dental handpiece (Beltec, São Paulo, Brazil). All plates ended with a thickness of 2mm and were then pumiced with sandpaper, granulation 180, 600 and 1200. Thickness was measured again to ensure all were standardized with 2mm. The final polishing was performed with a mixture of pumice and water until a smooth surface was obtained. Once ready, all appliances were kept in water at room temperature for 24 hours, until the time their resistance to compression was tested in a universal mechanical testing machine (Stable Microsystems, London, United Kingdom). The strength was obtained in kgf (Figure 3).

1. Statistical Procedure

For the descriptive analysis of the force values (kgf), the medians and the interquartile range were calculated, with the differences between the formats (normal, with and without arch) being compared by the Kruskal-Wallis test, after testing data normality using the Shapiro-Wilk test. Comparisons between pairs were performed using the Mann-Whitney test. The significance level was set at 5% ($\alpha = 0.05$). Data were tabulated and analyzed using the statistical program BioEstat (version 5.0, Belém-PA, Brazil).

RESULT

Figure 4 shows the median values of the measured force at the time of fracture, according to the format of the prepared retainer plate. Among the three plate formats tested, the normal showed the greatest resistance, with a median about five times higher than the form without arch and three times higher than the format with arch. It was also observed that the plates with arch

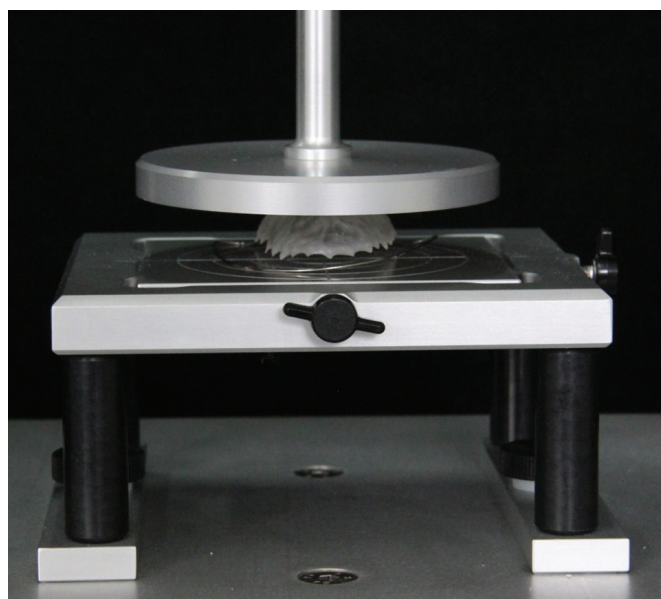


Figure 3. Plate disposed in the universal mechanical testing machine.

were significantly more resistant than the plates without arch, the median strength being 31% lower in the latter.

DISCUSSION

The Hawley retainer, removable appliance renowned in the orthodontic literature, occupies a prominent place in contemporary orthodontics. It is used after the completion of Corrective Orthodontics, aiming to keep the teeth in the position they were led in through the corrective orthodontic treatment^{6,8-11}. Despite widespread acceptance by orthodontists, it generates frequent complaints of patients who use it due to the discomfort provided by the acrylic covering the palate.

Attempting to alleviate this unpleasant effect, retainers with acrylic relief at the deepest region of the palate have been made, leaving them with a "U" form. However, with the sharp reduction of the acrylic, hypothetically the retainers would become more vulnerable, causing more fractures. To minimize this problem, empirically a segment of orthodontic wire is inserted in the anterior region of the palate.

It is noteworthy that the acrylic plate of the removable retainer consists of acrylic resin, which, besides joining the components of the apparatus, supports the stresses released by the active part and the retainer's fasteners when activated. These resins are organic compounds consisting in an acrylic resin polymer (powder) and a monomer (liquid) which, when mixed proportionally polymerize the resin and form the supporting base of the apparatus.

The results obtained after performing the tests showed that the plates in which the acrylic covered the whole palate were of superior resistance when compared to the other two evaluated types.

Hichens¹² observed the cost-effectiveness and patient satisfaction regarding the use of Hawley plates and vacuum made retainers in the UK. The results showed that the vacuum made retainer had a better cost-effectiveness than the Hawley plate. The

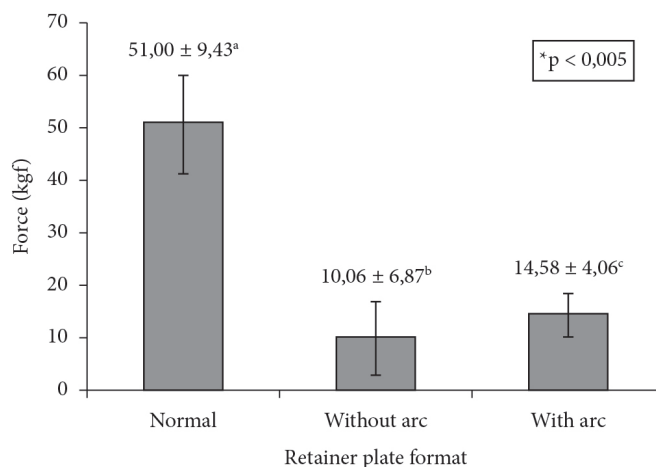


Figure 4. Median values \pm interquartile deviations of the measured strength at the time of the fracture, according to the format of the retainer plate. *The difference was tested using the Kruskal-Wallis test. ^{a,b,c}Values with different superscript letters are significantly different (Mann-Whitney).

first would have a smaller fabrication and repair cost as well as causing less discomfort to the patient's use and not impairing his diction too much, confirming its preference in that region¹².

When we evaluated the abandonment of this phase of treatment, it was found that, compared to the vacuum retainers, in a period longer than 2 years after removal of the fixed appliance, the Hawley retainer obtained greater support of the patients⁴. This highlights the need to provide greater comfort and optimize the resistance of these devices.

The results of this study demonstrated that when palate relief was performed on the plates, there was a significant reduction in their resistance (80%). However this resistance was enhanced by about 40% when the orthodontic wire was inserted into the acrylic.

Another study¹³, in which acrylic resin fatigue resistance in removable partial dentures was tested, found that when reinforced with fiberglass, these obtain superior resistance to those reinforced with metal. This suggests that the addition of other materials to the resins used in orthodontics may be an alternative to achieve greater durability for the apparatus. A similar result was found in this study, given that when internal orthodontic wire was added it greatly increased their strength.

Other authors¹⁴ compared four different cutout ways made in the front edge of the acrylic resin's palatine plates and arrived at the conclusion that the shape of the anterior margin of the plate

in prosthesis plays an important role in their fatigue resistance. In this study it was concluded that the shape of the acrylic plates of removable appliances also relates to their resistance, since, as already mentioned, the plates which covered the whole palate were more resistant.

Silva et al.¹⁵ evaluated the effect of treatment by microwave energy on the properties of flexural strength and microhardness of chemically activated acrylic resin Dencrilay Speed® (Dencril, Pirassununga, Brazil), and concluded that the treatment through microwave energy increased the flexural strength and reduced the microhardness of the evaluated acrylic resin¹⁵. Authors¹⁶⁻¹⁸ mention that occurrences such as fractures due to material fatigue are directly related to its resistance to flexion, and consequently, reinforcements and / or treatments of the acrylic resin are proposed to improve this property¹⁹⁻²².

CONCLUSION

It can be concluded with the completion of this study that:

Reduction of acrylic in the retainers' plates is directly related to the reduction of the compressive strength;

The inclusion of the orthodontic wire within the acrylic increases the plate's resistance, being a good alternative when more comfort for the patient is desired without detriment of the mechanical characteristics of the retainer apparatus.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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