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INFLUÊNCIA DE DIFERENTES PERÍODOS DE IMERSÃO EM ENXAGUATÓRIOS BUCAIS EM UMA RESINA ACRÍLICA PARA USO ORTODÔNTICO

Porto Alegre

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Trabalho de Conclusão de curso apresentado ao Curso de Graduação em Odontologia da Faculdade de Odontologia da Universidade Federal do Rio Grande do Sul, como requisito parcial para obtenção do título de Cirurgião-Dentista.

Orientador: Prof. Dr. Fabrício Mezzomo Collares

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RESUMO

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O objetivo deste estudo foi avaliar a influência da imersão em diferentes enxaguatórios bucais na dureza, rugosidade e cor de uma resina acrílica quimicamente ativada. Para tanto, foram confeccionados corpos de prova utilizando uma resina acrílica quimicamente ativada, de uso comercial para Ortodontia, da marca Orto Clas®. Os corpos de prova foram subdivididos em 45 grupos (n=5), de acordo com o enxaguatório bucal e o tempo de imersão correspondente. Foram utilizados os seguintes enxaguatórios: PlaxClassic®, Plax® sem álcool, Listerine®, Periogard® e Periogard® sem álcool nos tempos de imersão de 1 hora, 2 horas, 4 horas, 6 horas, 8 horas, 10 horas, 12 horas, 24 horas e 7 dias. Para os testes de dureza e rugosidade, os corpos de prova foram lixados utilizando-se lixas de carbeto de silício em uma seqüência decrescente de granulação e, posteriormente, polidos em uma máquina politriz com pasta para polimento. Foram mensurados 3 valores iniciais da rugosidade superficial para cada corpo de prova, obtendo-se assim os valores médios. Para o teste de dureza superficial Knoop, obtiveram-se os valores médios de dureza inicial, após 3 medições, para cada corpo de prova. Cada grupo foi então submetido à imersão em um enxaguatório diferente, em diferentes tempos, de maneira independente. Transcorrido o tempo, os grupos foram novamente submetidos aos testes de rugosidade e dureza superficial, obtendo-se assim, as médias finais. Para a análise colorimétrica, os corpos de prova foram divididos em 45 grupos (n=3), medindo-se a cor antes e depois da imersão nos colutórios e no tempos correspondentes. O pH dos enxaguatórios foi mensurado utilizando-se um pHmetro, obtendo-se o valor médio para 5 medições cada. Os dados de rugosidade, dureza e cor foram analisados através de ANOVA de duas vias, e os dados do pH através de ANOVA de uma via a um nível de significância de 5%. Todos os enxaguatórios diminuíram os valores de microdureza superficial apos 7 dias de imersão. Listerine® apresentou diminuição no valores de microdureza em todos os tempos testados. Plax® sem álcool e Listerine® apresentaram após 12 h de imersão, diferença estatisticamente significativa para o aumento nos valores de rugosidade superficial. Listerine® apresentou um aumento significativo na variação de cor apos 12 h de imersão. A imersão em enxaguatórios teve influência sobre as propriedades da resina acrílica o que poderia resultar na diminuição da longevidade dos aparelhos ortodônticos removíveis.

Palavras-chave: Resina acrílica. Enxaguatórios bucais. CIElab.

ABSTRACT

ROSTIROLLA, Flávia Veronezi. **Influence of long-term immersion in mouthwashes on orthodontic acrylic resin**. 35f. 2012. Final Paper (Graduation in Dentistry) – Faculdade de Odontologia, Universidade Federal do Rio Grande do Sul, Porto Alegre, 2012.

The aim of this study was to evaluate the influence of long-term immersion in different mouthwashes on microhardness, roughness and color stability of an acrylic resin.Specimens of an orthodontic autopolimerizing acrylic resin (Orto Clas®) were produced and randomly divided into 45 groups (n=5), in accordance with the time of immersion and the chemical solutions tested. Five commercial mouthwashes were tested: Plax® Classic, Plax® alcohol free, Listerine®, Periogard® and Periogard® alcohol free in immersion times of 1 hour, 2 hours, 4 hours, 6 hours, 8 hours, 10 hours, 12 hours, 24 hours and 7 days. Knoop hardness and roughness samples had any excess removed by polishing using progressively finer grades of silicon carbide paper. To obtain a smooth and flat surface, the specimens were finished with 220, 400 and 600-grit sandpaper impregnated with a diamond suspension in a polishing machine. Mean surface roughness of each test specimen was obtained after three initial measurements. Three indentations were made on each specimen and the initial values were obtained. Each group was immersed in a different mouthwash for a different period. After immersion time in respective solution, the specimens were submmited to the final roughness and microhardness measurements and the final mean values were recorded. For the colorimetric analysis, specimens were randomly divided into 45 groups (n=3) and color measurements were taken before immersion, as a control, and after at the same time intervals noted. Mouthwashes pH values were measured using a pH meter and after five measurements, the mean value for each mouthwash was taken. Statistical analysis was performed using two-way ANOVA (microhardness, roughness and colorimetric analysis), one-way ANOVA (pH) at a 0.05 level of significance. All mouthwashes decreased the surface microhardness values after 7 days of immersion. Plax® alcohol free showed no statistical significant difference among immersion times in roughness values. Listerine® showed decrease on microhardness values in all times tested. Plax®alcohol free and Listerine® at 12 hours showed statistically significant difference ($p<0.05$). Listerine® presented a significant increase on color variation after 12 hours of immersion. The immersion in mouthwashes influenced acrylic resin properties, which could lead to decreased longevity of removable orthodontic appliances.

Keywords: Acrylic resin. Mouthwashes. CIElab.

SUMÁRIO

1 INTRODUÇÃO

O tratamento ortodôntico para terapias miofuncionais e pequenas movimentações dentárias aumenta a contaminação microbiana na cavidade oral [10]. Nos aparelhos ortodônticos removíveis, a formação de biofilme pode ocorrer nos fios ortodônticos[8], nos grampos e molas[2] e nas bases acrílicas[12], pois estas estão mais propensas à colonização de microrganismos devido a presença de porosidades subsuperficiais[16]. Para evitar a proliferação microbiológica, a técnica da escovação parece ser uma conduta adequada de se promover a remoção do biofilme aderido à superfície do acrílico. No entanto, fatores como a idade e a destreza manual dos pacientes podem interferir na qualidade destes resultados[21].

O uso de agentes antimicrobianos, como os enxaguatórios bucais, pode auxiliar na manutenção da saúde bucal de pacientes usuários de aparelhos ortodônticos removíveis, controlando o crescimento do biofilme[4]. Os enxaguatórios bucais mais comumente utilizados, devido à sua eficiência são clorexidina[20], triclosan[19], cloreto de cetilpiridínio[24] e soluções à base de óleos essenciais[22]. Por outro lado, soluções desinfetantes para uso em aparelhos ortodônticos removíveis não devem apresentar influência negativa nas propriedades dos materiais após o processo de imersão. A imersão em soluções pode promover a plastificação das cadeias do polímero, levando à degradação do material, aumentando a sorção de água e solubilidade[5].

A resina acrílica utilizada para a confecção de aparelhos ortodônticos removíveis é um material que deve apresentar alguns requisitos para seu uso, tais como estabilidade dimensional e de cor[27] e ser passível de polimento e desinfecção[11]. Desinfetantes químicos como clorexidina, peróxidos, perborato e hipoclorito de sódio e glutaraldeído apresentaram alterações tanto na superfície quanto nas propriedades do material submetido à desinfecção química, como resistência à flexão[17], estabilidade de cor[7], rugosidade[7,13] e dureza[13]. Uma alternativa para a desinfecção das bases acrílicas são as soluções químicas de uso caseiro[12]. No entanto, ao conhecimento dos autores, não existe nenhum estudo avaliando a imersão, em diferentes períodos de tempo, de dispositivos acrílicos para uso ortodôntico em enxaguatórios bucais.

2 OBJETIVOS

Avaliar a influência da imersão em diferentes enxaguatórios bucais na dureza, rugosidade e cor de uma resina acrílica quimicamente ativada.

3 ARTIGO

Este trabalho de conclusão de curso se apresenta na forma de artigo científico, escrito na língua inglesa e segue as normas referentes ao periódico *Journal of Applied Oral Science,* para o qual será submetido.

ABSTRACT

Influence of Long-Term Immersion in Mouthwashes on Orthodontic Acrylic Resin

Introduction: The aim of this study was to evaluate the hypotesis that the effects of the different mouthwashes and the different immersion times have no influence on acrylic resin properties.

Methods: Specimens of an orthodontic autopolimerizing acrylic resin (OrtoClas®; São Paulo, Brazil) were produced and immersed in five mouthwashes: Plax® Classic (Colgate®); Plax® alcohol free (Colgate®); Listerine® (Johnson & Johnson®); Periogard® (Colgate®) and Periogard® alcohol free (Colgate®). Nine different immersion times were used (1 h, 2, 4, 6, 8, 10, 12, 24 h, 7 days) for each evaluated mouthwash, totalizing 45 groups. Before and after immersion, specimens were submitted to superficial Knoop microhardness (n=5), roughness (n=5), in Ra parameter, and colorimetric analysis, CIElab, (n=3).

Results: All mouthwashes decreased the surface microhardness values after 7 days of immersion. Plax® alcohol free showed no statistical significant difference among immersion times. Listerine® showed decrease on microhardness values in all times tested. Plax® alcohol free and Listerine® at 12 h showed a statistical significant difference ($p<0.05$) increase on roughness values. Listerine® presented a significant increase on color variation after 12 h of immersion.

Conclusion: The immersion in mouthwashes influenced acrylic resin properties, which could lead to decreased longevity of removable orthodontic appliances.

INTRODUCTION

The orthodontic treatment for myofunctional therapies and small movements increase the surface microbial contamination in the oral cavity[10]. On the acrylic removable devices, the biofilm formation may occur in orthodontic wires[8], clasps and springs[2] and acrylic baseplates[12], because this areas are more prone to colonization due to the subsurface porosities[16]. To avoid the biological proliferation tooth brushing seems to be an adequate way to remove the biofilm attached on the surface of acrylic. However factors such as age and manual dexterity of patients may interfere in the quality of its results[21].

The use of antimicrobial agents, such as mouthwashes, can assist in the maintenance of oral health of patients' users of removable orthodontic devices, controlling the growth of biofilm[4]. The most commonly used mouthwashes for biofilm control due its efficiency are chlorhexidine[20], triclosan[19], cetylpyridinium chloride[24] and essential oils[22]-based solutions. On the other hand, a disinfectant for removable acrylic appliances should have no negative influence on materials properties after immersion. The immersion in solutions could promote the plasticization of polymer chains, leading to the degradation of material, increasing the water sorption and solubility[5].

Acrylic resin used for removable orthodontic appliances is a material that must present requirements to use as dimensional and color stability[27]and be capable of polishing and disinfection[11]. Chemical disinfectants such as chlorhexidine, peroxides, sodium perborate, sodium hypochlorite and glutaraldehyde have shown surface and property alterations, such as tranverse strength[17], color stability[7], roughness[7,13] and hardness[13] on acrylic resins submmited to chemical disinfection. One alternative for disinfection of acrylic baseplates is the home-care chemical solutions[12]. However, at the best of our knowledge there is no study evaluating the long-term period immersion of orthodontic acrylic resin devices in mouthwashes.

Therefore, the aim of this study was to evaluate the effects of different mouthwashes and immersion times acting on acrylic resin. The null hypotesis tested is that the effects of the different solutions and the immersion times have no influence on acrylic resin properties.

MATERIALS AND METHODS

Test Specimen Production

An autopolymerizing acrylic resin for orthodontic use (OrtoClas®; São Paulo, Brazil) was manipulated according to the manufacturer's instructions. The sample was formed by 360 specimens. 225 specimens for the microhardness and roughness tests (n=5) and 135 specimens for the color test (n=3). Test specimens dimensions were (10 x 10 x 5 mm). The specimens for the microhardness and roughness tests were embedded in an autopolymerizing acrylic resin (JET; Campo Limpo Paulista, SP, Brazil), in order to prevent any problems with the alignment that could interfere in the tests. Knoop hardness and roughness samples had, immediately after polymerization, any excess removed by polishing using progressively finer grades (600-1200) of silicon carbide paper (3M of Brazil; São Paulo, Brazil). To obtain a smooth and flat surface, the specimens werefinished with 220, 400 and 600-grit sandpaper (Norton Abrasives; Saint-Gobain, Vinhedo, SP, Brazil) impregnated with a diamond suspension in a polishing machine (Arotec; Cotia, SP, Brazil) under water cooling. The specimens for the color analysis were not submmited to polishment. After polymerization, all the specimens were visually inspected, and were required to have a smooth surface without voids or porosity. If they have not, they were discarded.

Five commercial mouthwashes, Plax® Classic, Plax® alcohol-free, Listerine®, Periogard® and Periogard® alcohol-free, classified into two types (with alcohol or alcohol-free) were used. The composition of the chemical solutions is showed in Table 1.

Microhardness

The initial surface microhardness of resin was measured in three different areas of each specimen. Surface microhardness was determined using a hardness tester (Shimadzu HMV-2) equipped with a Knoop diamond pyramidal indenter. The longest diagonal of the indentation was measured and that was used in the following formula to calculate the Knoop hardness number (KHN):

$$KHN = [(14228\ c)/(d^2)]$$

Where:
c = applied load
d = measured length of long diagonal of indentation in mm

14228 = constant of indenter relating projected area of the indentation to the square of the length of the long diagonal.

Three indentations were made on each specimen. Testing was conducted using a 15 g load and a 10 second contact. The mean value of three indentations was considered as specimens KHN value. After those initial procedures, specimens were randomly divided into 45 groups consisting of five specimens each, in accordance with the time of immersion and the chemical solutions tested. The groups were immersed, in 30 ml of the mouthwashes Plax® Classic, Plax® alcohol-free, Listerine®, Periogard® and Periogard® alcohol-free for 1, 2, 4, 6, 8, 10, 12, 24 hours and 7 days. After immersion time in the respective solution, each test specimen was washed with destilled water for 10 s and dried. Then, the second measurements of microhardness were done in the same way as described for the initial measurements. The mean of values was recorded.

Roughness

Mean surface roughness of each test specimen was obtained after three measurements in different areas by using a surface analyzer (SJ-201 Mitutoyo-Japan). The surface roughness Ra is given by the value assigned to the area of peaks and valleys divided by the distance traveled by the sensor in a straight line providing the roughness Ra in micrometers. The rugosimeter provides the average of three lines of 0.25 micrometers. The specimens for the roughness test were the same as those used on microhardness test (Figure 1). Initial measurements were taken and then, specimens were randomly divided into 45 groups consisting of 5 specimens each, in accordance with the time of immersion and the chemical solutions tested. The groups were immersed, in 30 ml each, in the mouthwashes for 1, 2, 4, 6, 8, 10, 12, 24 hours and 7 days. After immersion time in the respective solution, each test specimen was washed with distilled water for 10 s and dried. Then, the second measurements of roughness were done in the same way as described for the initial measurements. The difference was calculated.

Colorimetric Analysis

The 135 specimens were randomly divided into 45 groups (n=3). Color measurements were taken before immersion, as a control, and after at the same time intervals noted. Color changes of each specimen were measured with a colorimeter CM2600 (Konica Minolta, Osaka - Japão). Color was accessed by measurements in L*a*b* coordinates with CIE illuminant D65 (average daylight) and a 10 degree viewing angle geometry. The L* represents the lightness or darkness of the object. The a* represents the red-green chromaticity of the object; +a* indicates chromaticity toward the red region and -a* indicates chromaticity toward the green region. The b* represents the yellow-blue chromaticity of the object, +b* indicates chromaticity toward the yellow region, and-b* indicates chromaticity toward the blue region. The test was conducted three times and the mean value of these three readings was recorded. ΔE of specimens were calculated between the control (before immersion) and at each time interval of immersion with the following equation:

$$\Delta E = ([\Delta L^*])^2 + ([\Delta a^*])^2 + ([\Delta b^*])^2)^{1/2}$$

After three measurements for each group test, the mean values of L*, a* e b* taken before and after immersion, the ΔE value was taken for each mouthwash.

Mouthwashes pH

The pH values of the chemical solutions were measured at room temperature (20°C) by using a digital pH meter (HANNA - pH 21). The equipment was calibrated with deionized water before samples were measured. Samples of 40 ml of each solution were analyzed before specimens immersion. After five measurements, the mean value for each mouthwash was taken.

Statistical Analysis

The normality of data was evaluated using Kolmogorof- Smirnov test. Statistical analysis was performed using two-way ANOVA (microhardness, roughness and colorimetric analysis), one-way ANOVA (pH) and Tukey’s post-hoc test at the 0.05 level of significance.

RESULTS

Microhardness

All mouthwashes decreased the surface microhardness values after 7 days of immersion. Plax® alcohol free showed no statistical significant differences among immersion times within the same mouthwash between 1 to 24 h. However, at 7 days, its value was different at a statistically significant level, compared with others solutions. At 7 days, Periogard® showed its highest difference on microhardness value over time ($p<0.05$). Listerine® showed decrease on microhardness values in all times tested (Figure 2).

Roughness

In general, the mouthwashes increased the surface roughness of acrylic resin. However only the testing groups Plax® alcohol free at 12 h and Listerine® from 12 h showed statistically significant increase values, within the same mouthwash and when compared with others ($p<0.05$). ΔRa values are shown in Figure 3.

Colorimetric Analysis

The colorimetric analysis using ΔE revealed differences between times within each mouthwash (Figure 4). However, no significant difference was shown in Plax® alcohol free, Plax® Classic and Periogard® groups independently of time. When solutions were compared with each other, Listerine® was the only one presenting a significant increase on color variation after 12 h of immersion.

Mouthwashes pH

The pH solutions values ranged from 4,11 (±0.07) to 7 (±0.04), showing statistically significant difference among groups. Plax® Classic pH value was 7 (±0.04). Listerine® matches the lowest pH (Table 2).

DISCUSSION

The use of removable orthodontic appliances (ROA) results in greater biofilm accumulation on dental surface and retentive sites of the appliance components[10]. Reducing the levels of microrganisms could prevent caries onset[26], halitosis[28], candidiasis[14]. Therefore, antimicrobial agents, such as mouthwashes, have been advised for orthodontic patients to aid in the control of bacterial biofilm formation[4]. According to a systematic review, the mean wearing time of orthodontic removable appliances is 13.4 (±10.3) months[15]. Based on this data, nine periods of immersion on mouthwashes were defined to simulate, and even extrapolate, situations at home disinfection practice by orthodontic patients, as a possible attempt to offer research-based data for a home disinfection protocol to be prescribed by orthodontists. Disinfection by immersion in chemical solutions might predispose the acrylic resin to structural impairment due to sorption of water molecules and increase of solubility[5]. This study evaluated the effect of five of the most commonly commercial mouthwashes used, on the properties of an orthodontic autopolymerising acrylic resin. The results of our study showed that the acrylic resin properties were influenced by mouthwashes immersion. Therefore, the null hypothesis was rejected.

The microhardness of acrylic resin is closely related to surface charactheristics of ROA, which are subjected to constant abrasion during cleaning methods, storage environment and accidental impacts. The acrylic resin immersion in all mouthwashes resulted in a decrease in microhardness values after 7 days of immersion. The mouthwash Plax® alcohol free showed a pattern similar to mouthwashes with alcohol, probably due to superficial alterations produced by the acidity. The pH measurement of this mouthwash was 4.93. At 7 days, Periogard® showed its highest microhardness difference value over time ($p<0.05$). Asad et al[1] immersed acrylic resin specimens in a 0.5% chlorhexidine gluconate solution and showed alterations on microhardness values only after 7 days of storage. In the present study, test specimens were disinfected with a 0.12% chlorhexidine digluconate. Periogard® is an alcohol-based mouthwash (11.6%) and the alcohol solvent action could also explain the changes in the surface of the acrylic. The resin can slowly absorb the disinfectant, altering the structure of the polymer[29]. Listerine® showed decrease on microhardness values in all times tested. Listerine® antibacterial activity is claimed to be due to the combination of four essential oils: eucalyptol, menthol, methyl salicylate, and thymol. The essential oils act on the surface of the resin and are a potential source of harm because of its solvent action for acrylic and other thermoplastic resins[25]. This may explain the decreased hardness shown by the acrylic resin after immersion in Listerine®. At 7 days of immersion in Listerine®, the specimens showed a slight but significant increase in hardness values. This confirms the previously described in literature softening effect of ethanol over acrylic resins[21,29]. It seems that ethanol, as well as water, helps to move the polymer chains apart and allows them to slide (plastically deform) more easily[21]. This decrease in KHN values for PMMA is also caused by the plasticization effect enhanced by the ethanol, which penetrates the matrix and expands the space between the chains[23].

Roughness of acrylic surface is of paramount importance to microorganism colonization on acrylic surface. The five mouthwashes tested increased the surface roughness in all tested groups. However, for microbial adhesion to occur, it is necessary a minimal roughness of 0.2 μm, which is the acceptable threshold value[3]. In this study, only two groups showed values higher than 0.2 μm. Listerine® after 12 h immersion, presented values ranging from 0.6 to 1.6 μm. Plax® alcohol free showed an increase on roughness values after 12 h immersion, from 0.12 to 1.05 μm. It may be assumed that the higher acidity may have caused the degradation of the superficial layer of the acrylic resin, resulting in an increase of the roughness values. Listerine® had the lowest pH value compared with others mouthwashes, showing a pH value of 4.11 and Plax® alcohol free, as referred before, 4.93. The continuous exposure of the material to these mouthwashes promoted a removal of this superficial layer, exposing a subsurface region of the acrylic resin, which could explain the decreased roughness values from 24 h to 7 days immersion on Plax® alcohol free. This roughening effect could cause patient's discomfort and became more susceptible to microorganisms colonization and biofilm formation.

In this study, a digital colorimeter was used to measure the color changes, using the ΔE as a parameter. Instrumental color analysis offers a potential advantage over visual color determination, because instrumental readings are objective, can be quantified, and are more rapidly obtained. The results showed that from the immersion period of 12 h immersion, Listerine® presented a significantly greater variation in compared to others mouthwashes, which can be explained by to changes in surface topography of the acrylic resin that influence the parameters of colorimetric measurement[9,28]. Moreover, there was visibly interaction of the green dye (CI 42053) presented in Listerine® with the acrylic resin, especially after a period of 12 h of immersion, what was confirmed by colorimetric assessment. This colorant influences the values of a+ and b+ parameters in order to reduce them, changing the final ΔE by an increase in the Δa and Δb of the samples. It may probably be explained by what is referred to as a crowding effect[6,9], when higher pigment concentrations results in an interaction between the colorant particles and leads to a deviation from de linear behavior. To relate the color differences (ΔE) to a clinical environment, there is a quantifying method by the Natural Bureau of Standards (NBS), which uses the formula NBS units= ΔE X 0.92. Lai et al. (2003) reported that ΔE values greater than 2 were considered visually perceptible and a Natural Bureau of Standards (NBS) unit of greater than 3 was considered unacceptable. Regarding the Plax® alcohol free, Plax® Classic and Periogard® groups, the lack of significant difference in the values of ΔE between times within groups can be related to changes in the surface, since in these groups, the difference in roughness also showed no significance[6,9].

The limitations of this study include the fact that the immersion procedures were conducted without intervals of time and the specimens were submmited to the mouthwashes action continuously. Patients do not continuously expose their removable appliances to mouthwashes solutions. The in vivo oral environment action is intermittent, and between the immersion processes the chemical solutions components, as ethanol and acids, may be eluted. At this time, acrylic resin will adsorb water molecules, which act as a plasticizer to a lesser extent than ethanol. In other words, the harmful effects on acrylic resin surface and color might be less significant. Furthermore, at the best of author’s knowledge, this is the first study evaluating five commercial mouthwashes in nine different immersion times. The commercial mouthwashes were chosen for their widespread use.

CONCLUSION

In the establishment by orthodontists of a home disinfection protocol, the choice of mouthwashes should be performed with caution. In this study the immersion in mouthwashes influenced acrylic resin properties, which could lead to decreased longevity of ROA.

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TABLES

Table 1. Mouthwashes, composition and batch numbers of solutions used.

Material	Composition	Batch numbers
Plax® Classic	Aqua, sorbitol, alcohol, glycerin, sodium lauryl sulfate, sodium methyl cocoyltaurate, PVM/MA copolymer, aroma, dosodium phosphate, sodium hydroxide, triclosan, sodium saccharin, CI 16035	BR122A
Plax® alcohol free	Aqua, glycerin, propylene glycol, sorbitol, PEG-40 hydrogenated castor oil, aroma, phosphoric acid, sodium benzoate, cetylpiridinium chloride, sodium fluoride 0.05%, sodium saccharin	BR123B
Listerine® Cool Mint	Thymol, Eucalyptol, Methyl Salicylate, Menthol, Aqua, Sorbitol, Alcohol, Poloxamer 407, Benzoic Acid, Aroma, Sodium Saccharin, Sodium Benzoate, CI 42053	3140B13
Periogard®	0.12% chlorhexidinedigluconate, 11.6% alcohol, glycerin, PEG-40 sorbitandiisostearate, flavor, sodium saccharin, and FD&C Blue No. 1.	12BR121A
Periogard® alcohol free	Aqua, glycerin, sorbitol, PEG-40, hydrogenated castor oil, chlorhexidinedigluconate, aroma, citric acid, CI 42090	BR123A

Table 2. pH values of commercial mouthwashes before samples immersion.

Mouthwash	pH
Periogard®	5.05 (±0.03)^{B}
Periogard® alcohol free	4.99 (±0.02)^{C}
Listerine® Cool Mint	4.11 (±0.07)^{E}
Plax® Classic	7.0 (±0.04) ^{A}
Plax® alcohol free	4.93 (±0.02)^{D}

Different capital letters indicate difference among the groups. ($p<0.05$)

FIGURES

Figure 1. Flowchart of the study methodology.

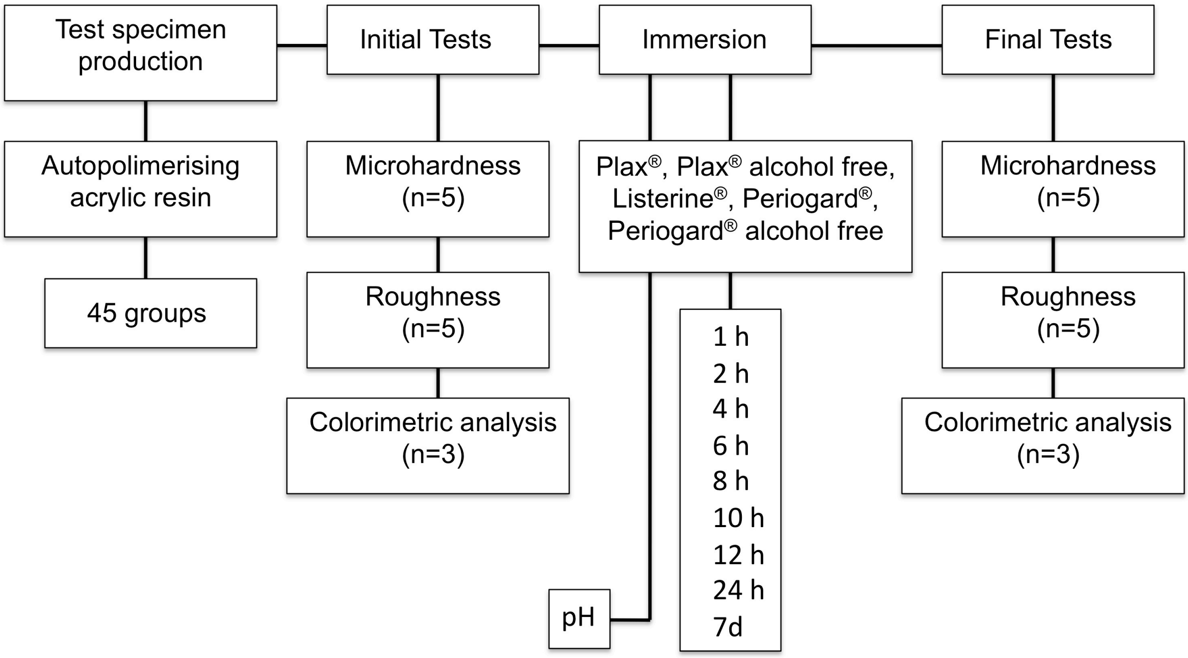


Figure 2. ΔKnoop hardness values after and before immersion in mouthwashes.

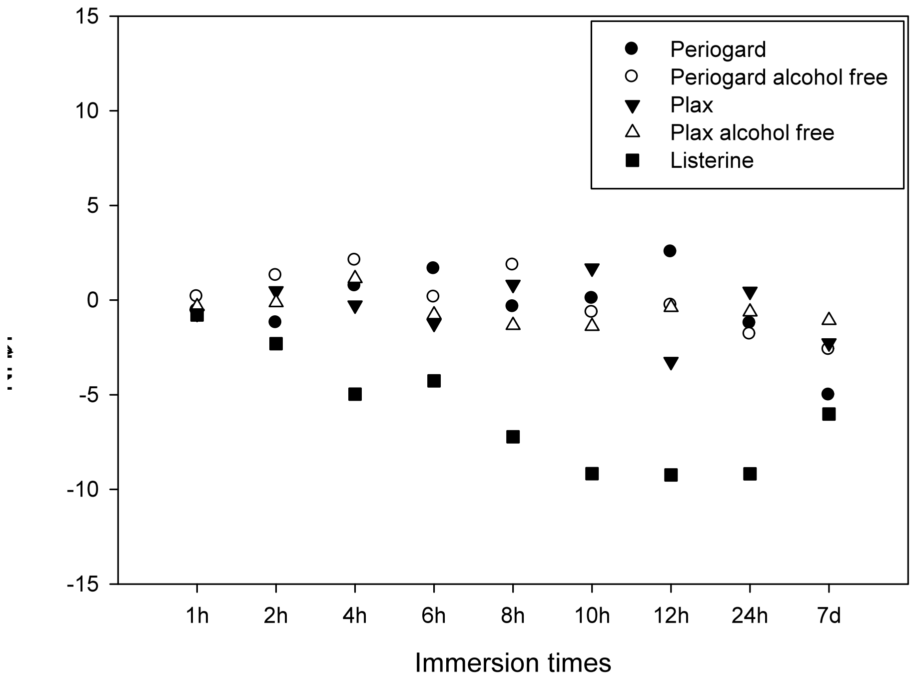


Figure 3.ΔRoughness value, in μm, after and before specimens immersion in mouthwashes.

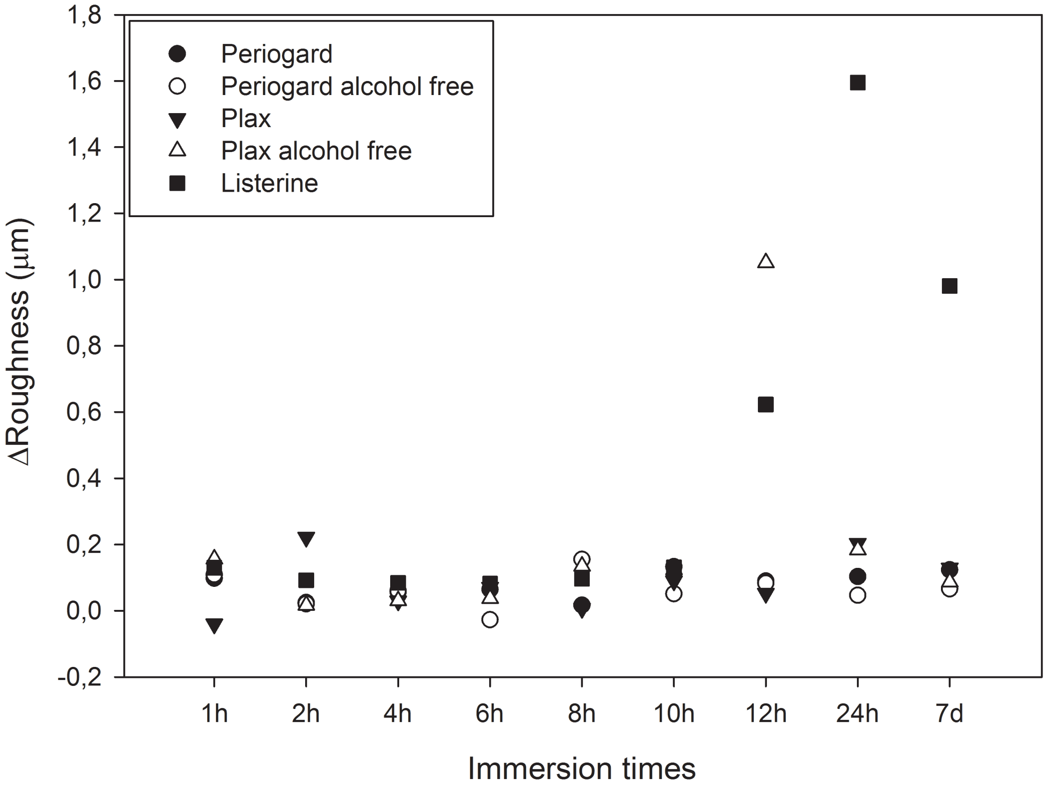
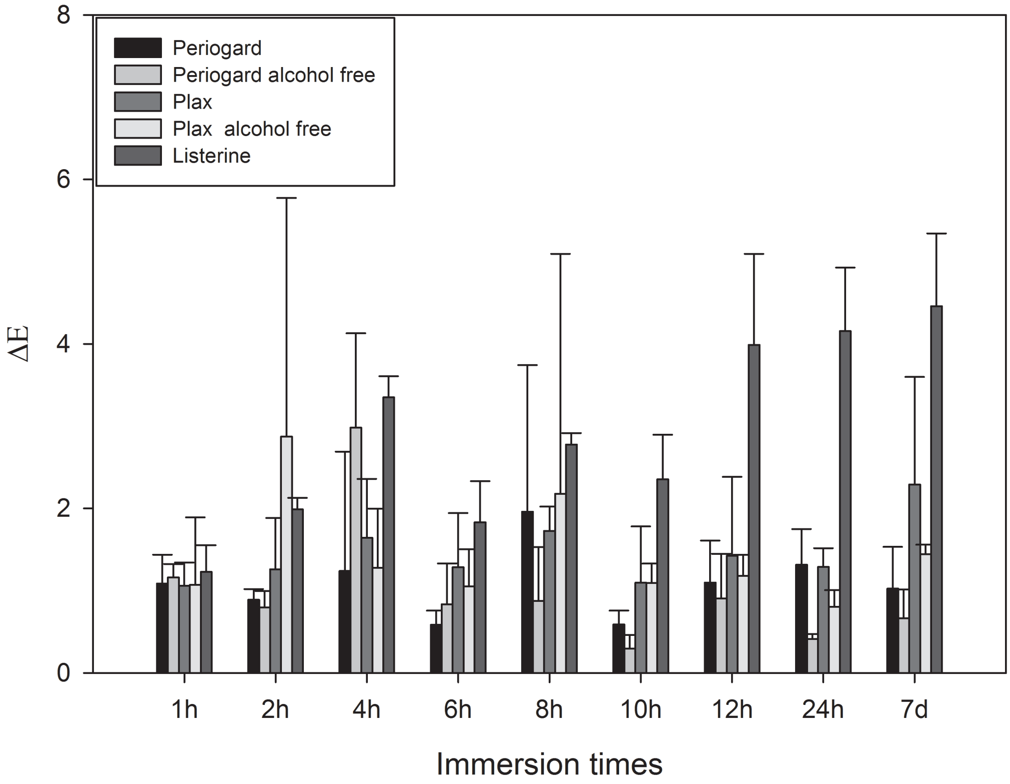


Figure 4. ΔE value of colorimetrics analysis in all times of immersion.



4 CONSIDERAÇÕES FINAIS

Os achados desse estudo sugerem que, tanto a composição das soluções desinfetantes, quanto o tempo de imersão escolhido, têm influência direta sobre a microdureza, a rugosidadee a estabilidade de cor da resina acrílica. Alterações nessas propriedades podem ocasionar uma diminuição na longevidade dos aparelhos ortodônticos removíveis.

No Apêndice A, encontram-se as médias e desvios padrão dos valores de microdureza antes e após a imersão nos enxaguatórios. Observa-se que, a partir de 1 hora de imersão e durante todos os tempos testados, o enxaguatório Listerine® já apresenta diferença estatisticamente significativa entre os valores iniciais e finais. No entanto, quando são analisadas as diferenças em percentual nos valores de microdureza (Apêndice B), essa diferença só é estatisticamente significativa a partir de 4 horas de imersão.

No Apêndice C, são mostrados as médias e desvios padrão dos valores de rugosidade antes a após a imersão dos grupos. Nestes resultados, observa-se que o enxaguatório Plax® sem álcool a partir de 1 hora de imersão e o enxaguatório Listerine® a partir de 10 horas de imersão, já mostram diferença significativa entre os valores iniciais e finais, entretanto estas variações são somente significativas nos tempos mostrados no Apêndice D, onde se mostra as diferenças em percentual dos valores de rugosidade em função dos tempos e dos enxaguatórios. Analisando estes dados, pode-se observar que a partir das 12 horas de imersão, tanto os valores do enxaguatório Listerine®, quanto do enxaguatório Plax® sem álcool passaram a diferir de maneira estatisticamente significativa quando comparados com os diferentes tempos de imersão e também com os outros enxaguatórios.

A escolha dos enxaguatórios bucais utilizados nesse estudo foi dada devido ao seu uso amplamente difundido, por serem produtos facilmente encontrados no mercado e por sua facilidade de compra e uso.

As perspectivas para os resultados encontrados nesse estudo são a tentativa de auxiliar os ortodontistas no estabelecimento de um protocolo de desinfecção caseira, sugerindo-se que, para tal, a escolha dos enxaguatórios bucais seja feita com cautela. Com um protocolo bem estabelecido, a durabilidade dos aparelhos ortodônticos removíveis será maior. Esse fato diminuirá o número de trocas desses dispositivos, tornando o tratamento menos oneroso.

Ademais, isso pode significar um maior conforto para o paciente ortodôntico, uma vez que a preservação das propriedades da resina acrílica resultariam em maior longevidade do aparelho, resultando em diminuição das idas ao consultório para manutenções referentes à sua estrutura e susceptibilidade à colonização microbiana e assim, menores riscos à saúde geral, bucal e malodores.

APÊNDICE A – MÉDIAS E DESVIOS PADRÃO DOS VALORES INICIAIS E FINAIS DE MICRODUREZA EM FUNÇÃO DOS TEMPOS DE IMERSÃO E ENXAGUATÓRIOS

Tempos	Periogard sem álcool		Periogard		Listerine		Plax sem álcool		Plax com álcool	
	Antes	Depois	Antes	Depois	Antes	Depois	Antes	Depois	Antes	Depois
1 h	12,8(±1,7)a	13,0(±1,5)a	16,5(±1,0)a	15,9(±1,5)a	9,2(±5,9)a	9,0(±5,7)b	13,4(±1,1)a	13,0(±1,1)a	13,5(±1,5)a	12,7(±0,5)a
2 h	13,4(±0,6)a	14,7(±0,4)b	13,1(±0,3)a	14,3(±1,3)a	10,8(±6,4)a	9,7(±5,8)b	13,5(±0,7)a	13,4(±1,8)a	13,7(±0,9)a	14,2(±1,4)a
4 h	13,4(±0,9)a	15,5(±1,2)a	13,6(±1,3)a	14,3(±1,2)a	10,2(±6,0)a	6,4(±3,7)b	13,0(±1,7)a	14,2(±1,3)a	14,5(±2,2)a	14,2(±1,4)a
6 h	13,8±(,7)a	14,0(±1,1)a	13,0(±0,5)a	14,7(±0,5)b	9,5(±5,7)a	6,4(±3,7)b	13,4(±0,8)a	14,2(±1,7)a	15,3(±1,8)a	14,1(±1,0)a
8 h	13,5(±0,8)a	15,3(±1,5)a	13,6(±1,3)a	13,2(±1,0)a	10,6(±6,2)a	4,8(±2,7)b	16,0(±0,8)a	14,7(±2,7)a	14,4(±1,3)a	15,2(±1,2)a
10 h	14,8(±1,4)a	14,2(±1,4)a	14,3(±1,8)a	14,3(±1,8)a	11,8(±7,2)a	4,7(±2,3)b	13,1(±0,9)a	14,5(±1,5)a	13,2(±0,5)a	14,9(±1,3)b
12 h	10,9(±1,7)a	10,7(±0,9)a	10,5(±1,3)a	13,0(±0,4)b	10,4(±6,3)a	3,4(±1,9)b	13,6(±1,0)a	13,3(±0,8)a	14,4(±1,4)a	11,2(±1,4)b
24 h	15,7(±1,8)a	13,9(±0,9)a	14,5(±1,4)a	13,2(±0,2)a	9,8(±6,0)a	3,2(±1,9)b	12,9(±1,0)a	12,3(±0,3)a	12,5(±1,0)a	12,9(±1,2)a
7 d	15,2(±1,9)a	12,6(±0,3)b	15,4(±1,3)a	10,3(±0,4)b	10,3(±6,3)a	6,0(±3,1)b	13,0(±1,1)a	11,9(±0,2)b	14,4(±1,4)a	12,2(±0,3)b

Valores analisados por Teste t student pareado. Letras diferentes entre colunas Antes e Depois para um mesmo enxaguatório indicam diferença estatística.

APÊNDICE B – DIFERENÇA EM PERCENTUAL DOS VALORES DE MICRODUREZA EM FUNÇÃO DOS TEMPOS DE IMERSÃO E ENXAGUATÓRIOS

Tempos	Periogard sem álcool	Periogard	Listerine	Plax sem álcool	Plax com álcool
1 h	-1,6 (±4,1) A,B,C,a	3,2 (±9,9) B,a	6,3 (±6,1) F,a	1,8 (±13,9) A,a	4,7 (±7,7) A,B,C,a
2 h	-9,7 (±4,8) B,C,b	-2,3(±3,7) B,C,a,b	15,4 (±11,2) E,F,a	1,1 (±11,5) A,a,b	-4,2 (±14,7) B,C,b
4 h	-16,3 (±14,7) C,b	-6,5 (±15,1) B,C,b	36,3 (±8,1) C,D,a	-9,8 (±14,2) A,b	0,6 (±14,1) B,C,b
6 h	-1,2 (±7,6) A,B,C,b,c	-12,8 (±6,2) B,C,c	32,8 (±8,7) D,E,a	-5,8 (±10,5) A,b,c	6,9 (±14,0) A,B,C,b
8 h	-14,0 (±13,0) C,c	2,18 (±9,70) B,b,c	55,0(±8,4) A,B,C,a	8,0 (±18,9) A,b	-6,2 (±11,1) C,b,c
10 h	-3,7 (±13,4) A,B,C,b	0,05 (±8,9) B,b	58,7 (±11,1) A,B,a	-10,9 (±12,8) A,b	-12,6 (±7,0) C,b
12 h	-1,6 (±8,1) A,B,C,c	-25,7 (±16,7) C,d	68,5 (±5,2) A,a	2,3 (±11,4) A,c	21,6 (±14,0) A,b
24 h	10,8 (±10,2) A,B,b	7,9 (±8,3) B,b	68,6 (±2,8) A,a	4,3 (±9,5) A,b	-4,5 (±16,1) B,C,b
7 d	16,2 (±10,4) A,b	32,3 (±7,2) A,a,b	45,8 (±11,0) B,C,D,a	7,8 (±7,4) A,c	15,1 (±8,2) A,B,b

Letras maiúsculas diferentes mostram diferença nas colunas e letras minúsculas diferentes mostram diferença nas linhas ($p<0,05$).

APÊNDICE C – MÉDIAS E DESVIOS PADRÃO DOS VALORES INICIAIS E FINAIS DE RUGOSIDADE EM FUNÇÃO DOS TEMPOS DE IMERSÃO E ENXAGUATÓRIO

Tempos	Periogard sem álcool		Periogard		Listerine		Plax sem álcool		Plax com álcool	
	Antes	Depois	Antes	Depois	Antes	Depois	Antes	Depois	Antes	Depois
1 h	0,26(±0,04)a	0,37(±0,07)a	0,19(±0,07)a	0,29(±0,08)b	0,27(±0,16)a	0,40(±0,23)a	0,16(±0,03)a	0,32(±0,09)b	0,21(±0,07)a	0,17(±0,02)b
2 h	0,16(±0,03)a	0,18(±0,03)a	0,20(±0,11)a	0,23(±0,10)a	0,17(±0,06)a	0,26(±0,08)a	0,17(±0,02)a	0,19(±0,01)b	0,16(±0,04)a	0,39(±0,15)a
4 h	0,17(±0,02)a	0,23(±0,07)a	0,17(±0,03)a	0,23(±0,08)a	0,29(±0,12)a	0,37(±0,16)a	0,16(±0,02)a	0,19(±0,13)a	0,16(±0,01)a	0,19(±0,04)a
6 h	0,25(±0,08)a	0,22(±0,10)a	0,16(±0,02)a	0,23(±0,06)a	0,19(±0,08)a	0,28(±0,12)a	0,18(±0,03)a	0,22(±0,11)a	0,17(±0,04)a	0,24(±0,03)b
8 h	0,18(±0,04)a	0,34±(,17)a	0,14(±0,05)a	0,16±(0,05)a	0,20(±0,05)a	0,30(±0,11)a	0,15(±0,01)a	0,29(±0,15)a	0,22(±0,03)a	0,23(±0,11)a
10 h	0,17(±0,01)a	0,22±(,03)b	0,15(±0,03)a	0,29(±0,08)b	0,19(±0,09)a	0,33(±0,04)b	0,18(±0,02)a	0,31±(,06)b	0,14(±0,25)a	0,23±(0,09)a
12 h	0,18(±0,03)a	0,27±(,17)a	0,18(±0,02)a	0,27(±0,17)a	0,19(±0,04)a	0,81(±0,11)b	0,15(±0,02)a	1,20(±0,62)b	0,16(±0,02)a	0,21(±0,03)a
24 h	0,26(±0,05)a	0,31(±0,14)a	0,21(±0,02)a	0,31(±0,14)a	0,21(±0,09)a	1,80(±0,44)b	0,18(±0,03)a	0,36(±0,15)a	0,14(±0,02)a	0,34(±0,09)a
7 d	0,28(±0,09)a	0,34(±0,05)a	0,22(±0,06)a	0,34(±0,05)b	0,16(±0,02)a	1,14(±0,20)b	0,16(±0,07)a	0,25(±0,04)b	0,19(±0,05)a	0,32(±0,04)b

Valores analisados por Teste t student pareado. Letras diferentes entre colunas Antes e Depois para um mesmo enxaguatório indicam diferença estatística.

APÊNDICE D – DIFERENÇA EM PERCENTUAL DOS VALORES DE RUGOSIDADE EM FUNÇÃO DOS TEMPOS DE IMERSÃO E ENXAGUATÓRIOS

Tempos	Periogard sem álcool	Periogard	Listerine	Plax sem álcool	Plax com álcool
1 h	-46,5 (±42,3) A, a	-60,8(± 52,6) A, a	-113,1 (± 200,9) A, B, a	-101,8 (± 68,5) A, a	10,2 (± 33,9) A, a
2 h	-16,1 (±22,5) A, a	-26,8 (±68,1) A, a	-75,8 (± 88,1) A, a	-10,4 (± 6,1) A, a	-149,3 (± 124,0) A, a
4 h	-40,5 (±58,6) A, a	-37,2 (± 54,1) A, a	-50,9 (± 74,4) A, a	-14,4 (± 64,5) A, a	-19,8 (± 32,3) A, a
6 h	3,9 (±49,4) A, a	-42,9 (± 48,2) A, a	-46,1 (± 57,9) A, a	-17,4 (± 49,0) A, a	-45,8 (± 34,1) A, a
8 h	-106,8 (±149,0) A, a	-17,5 (± 33,3) A, a	-73,9 (± 129,3) A, a	-88,7 (± 100,2) A, a	-10,2 (± 69,9) A, a
10 h	-31,3 (±24,5) A, a	-97,5 (±78,9) A, a	-91,5 (± 75,6) A, a	-69,5 (± 36,4) A, a	-73,1 (± 82,1) A, a
12 h	-41,6 (±78,0) A, a	-60,5 (±85,8) A, a	-339,7 (± 105,1) B, b	-665,4 (± 362,5) B, c	-36,7 (± 33,3) A, a
24 h	-16,0 (±37,4) A, a	-20,7 (±54,1) A, a	-908,9 (± 525,9) D, b	-109,3 (± 93,6) A, a	-146,8 (± 39,7) A, a
7 d	-31,3 (±37,5) A, a	-69,3 (± 49,6) A, a	-622,4 (± 90,4) C, b	-102,1 (± 153,5) A, a	-78,1 (± 65,1) A, a

Letras maiúsculas diferentes mostram diferença nas colunas e letras minúsculas diferentes mostram diferença nas linhas ($p<0,05$).