UNIVERSIDADE ESTADUAL DE MARINGÁ
CENTRO DE CIÊNCIAS DA SAÚDE
DEPARTAMENTO DE ODONTOLOGIA
MESTRADO EM ODONTOLOGIA INTEGRADA

INFLUÊNCIA DO MÉTODO DE POLIMERIZAÇÃO DA RESINA ACRÍLICA EM SUAS CARACTERÍSTICAS FÍSICAS E ADESÃO DE MICROORGANISMOS

MARINGÁ
– 2010 –

WELLINGTON MENDES CARVALHO

INFLUÊNCIA DO MÉTODO DE POLIMERIZAÇÃO DA RESINA ACRÍLICA EM SUAS CARACTERÍSTICAS FÍSICAS E ADESÃO DE MICROORGANISMOS

Dissertação apresentada ao Departamento de Odontologia da Universidade Estadual de Maringá como requisito para a obtenção do título de Mestre no Programa de Pós-graduação *Strictu sensu* em Odontologia Integrada.

Orientador: Prof. Dr. André Gasparetto.

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A Comissão Julgadora dos trabalhos de Defesa de Dissertação de Mestrado, em sessão pública realizada em 19 de março de 2010, considerou o candidato *Wellington Mendes Carvalho* aprovado.

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À minha mãe,

por tudo, sempre!

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“Quando a gente acha que tem todas as respostas, vem a vida e muda todas as perguntas.”

Luís Fernando Veríssimo

RESUMO

As resinas acrílicas de uso odontológico vêm sofrendo grandes mudanças, principalmente com o advento da polimerização por energia de microondas. Logo, torna-se necessário avaliar as propriedades destas novas resinas. O objetivo deste estudo foi avaliar comparativamente a resina acrílica convencional e a resina acrílica polimerizada por energia de microondas, com três diferentes protocolos de polimerização, quanto à: absorção de água, solubilidade, rugosidade superficial e adesão da levedura *Candida albicans*. Para isso, corpos de prova medindo 0,7cm x 0,7cm x 1mm foram confeccionados e divididos em 4 grupos: polimerizados por energia de microondas com 3 diferentes protocolos, sendo Grupo A o ciclo do fabricante, B um ciclo curto e C um ciclo longo. E o Grupo D para a resina de polimerização convencional (imersão em água quente). Para o calculo da absorção de água e solubilidade os corpos de prova (desidratados) foram pesados em balança analítica e imersos em água destilada, sendo que novas pesagens foram feitas a cada 24 horas, por 11 dias. A análise da rugosidade superficial foi feita através de escaneamento em Microscópio de Força Atômica (AFM). Para o ensaio de adesão, os corpos de prova foram expostos à uma concentração de *Candida albicans* (ATCC 90028) por uma hora e então a adesão foi quantificada utilizando a técnica de contagem de Unidades Formadoras de Colônias (UFC). Os resultados mostraram diferenças estatisticamente significantes entre os grupos para absorção de água (A ≠ B, B ≠ D e C ≠ D), solubil idade (A, B e C ≠ D) e rugosidade (entre todos os grupos testados), porém não houve diferença estatisticamente significante na adesão de microrganismos. Sendo assim concluiu-se que o tipo e o ciclo de polimeização causam alterações nas propriedades físicas da resina acrílica, porém não foi capaz de alterar o padrão de adesão da levedura *Candida albicans*.

Palavras-chave: resina acrílica, rugosidade superficial, absorção de água, solubilidade, adesão microbiana.

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1. INTRODUÇÃO

A exigência da sociedade é cada vez maior por um profissional capacitado, dinâmico, com uma sólida base de conhecimentos, mas também com flexibilidade para continuar aprendendo ao longo de sua vida profissional, de modo a não se desatualizar ante os novos conhecimentos, e ao mesmo tempo, não ficar alheio às transformações sociais. Diante de exigências tão complexas das demandas sociais, bem como do crescimento acelerado do volume de conhecimento, exige-se que o profissional de saúde tenha uma formação sólida que contemple tanto o conhecimento em sua área de especialização, como as habilidades e atitudes (BATISTA, 2003).

O distanciamento entre os mundos acadêmico e o da prestação real dos serviços de saúde vem sendo apontado em todo mundo como um dos responsáveis pela crise do setor da saúde. No momento em que a comunidade global toma consciência da importância dos trabalhadores de saúde e se prepara para uma década em que os recursos humanos serão valorizados, a formação de profissionais mais capazes de desenvolverem uma assistência humanizada e de alta qualidade e resolutividade torna-se evidente, tanto no atendimento particular como na atuação destes profissionais no Sistema Único de Saúde (SUS).

A excessiva especialização observada em alguns cursos da área da Saúde tem sido apontada, entre outros fatores, como uma das responsáveis pela elevação dos custos assistenciais. Em função disso, várias tentativas vêm sendo feitas para corrigir a relação especialistas/generalistas, sem prejuízo da qualidade. Essa especialização, que antes predominava na medicina, começa a ser observada também nas demais carreiras da saúde, como a Odontologia (ALMEIDA, 2005).

Neste assunto, o Curso de Odontologia da Universidade Estadual de Maringá (UEM) sempre foi inovador. Já em 1992, implementou mudanças no projeto pedagógico baseada em um currículo integrado. Estas mudanças foram consideradas inovadoras e já se encontravam em consonância com as Diretrizes Curriculares Nacionais (DCN) para os cursos de graduação em saúde, que só entraram em vigor a partir de 2002 (TERADA, 2004). No ano de 2006, o curso foi selecionado para o Programa Nacional de Reorientação da Formação Profissional em Saúde (Pró-Saúde), que visa ajustar a formação profissional para as reais necessidades do mercado brasileiro, valorizando a formação generalista e voltada para atuação no SUS (ALMEIDA, 2005).

Em 2008, teve início o Programa de Mestrado em Odontologia Integrada da UEM. Seguindo a mesma linha da graduação, o curso tem como proposta a capacitação de profissionais para atuação na formação de cirurgiões-dentistas em consonância com as DCN, que preconizam o perfil do profissional de odontologia com formação generalista, humanista, crítica e reflexiva, para atuar em todos os níveis de atenção à saúde, com base no rigor técnico e científico. Além disso, o profissional deve estar capacitado ao exercício de atividades referentes à saúde bucal da população, pautado em princípios éticos, legais e na compreensão da realidade social, cultural e econômica do seu meio, dirigindo sua atuação para a transformação da realidade em benefício da sociedade (BRASIL, 2005).

Assim, o ensino odontológico da UEM sempre fugiu ao padrão da maioria das escolas, que ainda é baseado no conceito tecnicista de Charles Godon e aperfeiçoado por Flexner e Gies no início do século XX, de aulas expositivas, com o conhecimento sendo explorado de forma compartimentalizada, centrado na figura do professor (ZILBOVICIUS, 2007). Essa mesma postura foi adotada na pós-graduação, onde se buscou os padrões de integralidade da atenção, interdisciplinaridade e trabalho em equipe, que são peças-chave para a obtenção de recursos humanos com capacidade para atender às necessidades do trabalho no campo odontológico de hoje.

2. CONCEITUAÇÃO DA LINHA DE PESQUISA

Seguindo a conceituação do Programa de Mestrado em Odontologia Integrada da UEM, buscou-se uma proposta de pesquisa que, embora laboratorial, estivesse em consonância com as necessidades e produzisse conhecimento para o sistema de saúde vigente.

Desde 2003, com o lançamento pelo Ministério da Política Nacional de Saúde Bucal - Programa Brasil Sorridente, foi incentivado a produção de próteses odontológicas utilizando como material base resina acrílica polimerizada por energia de microondas. Embora esta tecnologia tenha mais de trinta anos, ela nunca foi utilizada em larga escala, como agora. Entre 2004 e 2010 foram criados 323 Laboratórios Regionais de Prótese Dentária em todo o país, que produziram, apenas em 2009, 146.387 próteses odontológicas*.

Assim, embora existam muitos estudos comparando propriedades mecânicas e características superficiais entre diferentes tipos de resinas acrílicas, pouco se sabe sobre a influência destas diferenças na adesão e colonização do material por microorganismos patogênicos como *Candida albicans*, que podem causar inúmeros problemas aos usuários de próteses. Logo esta pesquisa laboratorial se integra à necessidade de conhecimento gerada pelo Sistema Único de Saúde.

* Dado coletado da base de dados do Sistema de Informação Ambulatorial do Sistema Único de Saúde (SIA/SUS), em 19/01/2010.

3. OBJETIVO GERAL

Avaliar as propriedades de absorção de água, solubilidade, rugosidade superficial e adesão de *Candida albicans* em resina acrílica convencional e polimerizada por energia de microondas, com três protocolos de polimerização.

4. APRESENTAÇÃO

O trabalho, na forma do artigo "*Influence of polymerization method on acrylic resin physical properties and microorganism adhesion*", está escrito e formatado de acordo com as normas de publicação da revista "*Journal of Prosthetic Dentistry*".

INFLUENCE OF POLYMERIZATION METHOD ON ACRYLIC RESIN PHYSICAL PROPERTIES AND MICROORGANIM ADHESION

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Statement of problem. The acrylic resin for Dentistry use has been suffering considerable changes, mainly with the advent of microwave energy polymerization. Thus, evaluate the new acrylic resin properties is necessary.

Purpose of study. To evaluate the properties of water sorption, solution, surface roughness, and *Candida albicans* adhesion in heat- and microwave-polymerized acrylic resin, with three different protocols.

Material and methods. Specimens measuring 7 x 7 x 1mm were produced and divided in 4 groups. For microwave energy polymerization: A (3 minutes at 360W + 4 minutes at 0W + 3 minutes at 810W), B (3 minutes at 540W), C (13 minutes a 90W with the flask in vertical position + 90 seconds at 540W with the flask in horizontal position), and D for heat cured acrylic resin (9 hours of hot water bath at 74ºC). Specimens were tested for water sorption, solubility, surface roughness, and *Candida albicans* adhesion.

Results. The results showed significant differences in water sorption, solubility and surface roughness in the groups tested ($P<0.05$). However, no significant differences have been showed in *Candida albicans* adhesion.

Conclusion. The results suggest that acrylic resin with different polymerization protocols has differences in physical properties, but these differences did not cause alterations in *Candida albicans* adhesion.

Clinical Implications

The study suggests that the type and polymerization method of acrylic resin can influence the physical properties but does not have effect in ***Candida albicans*** *adhesion.*

Polymethyl methacrylate (PMMA) is the most commonly material used in denture fabrication. Also named acrylic resin, this material was created in 1936 and since that time researchers have been studied for produce a PMMA with better polymerization method, physical and mechanical properties. The main studied characteristics are: hardness, flexural strength, residual monomer, dimensional alterations, porosity and surface roughness. Porosity and surface roughness are extremely connected with microorganism adhesion because these characteristics may help microorganism colonization and difficult both chemical than mechanical cleansing.[1]

For many years the PMMA polymerization was made by hot water bath. With the advances of science, new polymerization techniques were introduced and better polymers were developed. These advances created a new PMMA, microwave energy activated.[2] This polymerization method has been studied for more than thirty years. Microwave energy irradiation has the advantages of reducing processing time, decreasing cost, a cleaner method of processing, and a denture base with superior adaptation to the dental cast.[3]

Although the majority of physical characteristics of microwave-polymerized acrylic resins are similarly to hot water bath acrylic resins, some differences have been related. The differences in polymerization time and temperature can modify the chemical reactions and residual monomer release, consequently causing differences on porosity.[1,4,5] More porosity may cause higher water sorption and solubility levels of acrylic resin, reducing mechanical properties like hardness, resistance and dimensional stability.[6] Therefore, hydrophobic superficies like PMMA have exposed monomer units that interact with hydrophobic domains of proteins in the cell wall of microorganisms, establishing hydrophobic linkages and contributing to the adhesion of pathogenic microorganisms like *Candida albicans*.[7,8]

Surface roughness also can facilitate microorganism adhesion, considering because it produces areas with re-entrances that may help microorganism colonization.

Candida albicans is a fungal pathogen present in 30 – 60% of normal persons. Recently, this yeast has been studied with fresh interest, considering it becomes an important opportunistic pathogen in HIV infected patients.[9] The relationship between oral candidosis and denture use is well known. This pathology named denture-induced stomatitis is a common finding and studies showed epidemiologic rates varying among 11 to 67%.[10,11] The levels of *Candida* in saliva is higher in denture users than no denture users. Mainly in immunocompromised individuals, *Candida albicans* also can cause invasive candidosis, a disease with mortality level higher than 40%.[11,12,13]

Thus, the aim of this study was to evaluate the properties of water sorption, solution, surface roughness and *Candida albicans* adhesion in heat- and microwave-polymerized acrylic resins, with three different protocols.

MATERIAL AND METHODS

Preparation of specimens

Sixty specimens, 7 x 7 x 1mm, were manufactured using a sheet of wax (Epoxiglass; Ind Com Prod Quimicos Ltd, São Paulo, Brazil). The sheets were flasked in type III dental stone (Herodent Soli-Rock; Vigodent, Rio de Janeiro, Brazil) using a standard metal dental flask (Uraby; DLC, Sao Paulo, Brazil) for heat polymerization or plastic flask (Artigos Odontólogicos Clássico Ltd, Sao Paulo, Brazil) for microwave polymerization. After the gypsum had set completely, the flasks were boiled for 5 minutes to soften and eliminate the wax. The acrylic resin was then packed, and divided in four groups, following the polymerization protocols described in Table 1. The Group A follows manufacture's recommendations for microwave polymerization. Group B uses the shortest microwave polymerization protocol found in literature and Group C uses the longest one.[4] The Group D follows the manufacturer's recommendations for hot water bath polymerization.

After polymerization cycle, all specimens received the same treatment of finishing and polishing. They were ground using aluminum oxide papers (220-, 320- and 400-grit, sequentially). For mechanical polishing, a brush wheel (TMP-200; Equilam, Diadema, Brazil) with pumice slurry and a felt cone with chalk powder (Branco-Rio, OAB-ME, São Paulo, Brazil) were used. All of the specimens were polished by the same operator and exposed to the same procedures, as each mechanical polishing step was performed for 1 minute on each surface. All specimens were immersed in distilled water at 37ºC for 12 hours for residual monomer release.

Water sorption and solubility

Four specimens of each group were maintained in constant temperature of 37ºC for seven days and they weighted then in an analytical scale (Model Ax-204; Mettler-Toledo, Barueri, Brazil) with an accuracy of 0,0001g. This weight value is considered the inicial weight of the specimen (W_1) and after that the specimens were immersed in distilled water and maintained at 25ºC. So, once time for day the specimens were removed from water, dried in absorbent paper and weighted. After ten days, the last weight obtained was considered W_2. Then, the specimens were removed from water, dried in absorbent paper and maintained in constant temperature of 37ºC for seven days again. After that, the specimens were weighted again (W_3). The percentage of water sorption and solubility were determinate by the following formulas described by Kazanji and Watkinson and El-Hadary and Drummond, cited by León, Cury, and Garcia[14]:

Percent water sorption – $\%_{sorp} = \frac{(W_2 - W_3)}{W_1} \times 100$

Percent solubility – $\%_{sol} = \frac{(W_1 - W_3)}{W_1} \times 100$

Where:

W_1: initial weight of specimen

W_2: weight of specimen 10 days after immersion on water

W_3: final weight of specimen

Surface roughness

Surface roughness (Ra) of the specimens was measured using Atomic Force Microscopy – AFM (Model SPM-950033; Shimadzu, Tokyo, Japan) with frequency of 1Hz and definition of 256 x 256 points. Two specimens of each group were used where three random areas of 10 μm^2 were scanned from each specimen.

Microorganism and growth conditions

A reference strain of *Candida albicans* (ATCC 90028) originating from the mycology collection of the Laboratory of Mycology, Institute of Biomedical Sciences, University of São Paulo, were used in this study. The yeast was maintained in Sabouraud Dextrose Agar (SDA) (Difco; Lawrence, USA) at 25º C. The culture was reactivated by cultivation in SDA at 37º C before each experiment. Individual colonies isolated from pre-culture incubated by 18–24 h of the yeast strain was suspended in sterilized saline (SSS) and adjusted to a cell concentration of approximately 1.0 – 2.0 x 10^6 cells/ml, calibrated by Neubauer's Chamber (Preciss; São Paulo, Brazil).

Adherence assay

Using aseptic technique, three acrylic specimens from each group were placed in 12 x 80 mm sterile tubes containing 2 ml of previously standardized yeast suspension. They were then incubated for 1 h at 37º C in a shaker incubator (NT712; Nova Técnica, São Paulo, Brazil) with continuous shaking at 120 rpm. After incubation, specimens were washed with 2 ml of SSS. This process was repeated three times in order to remove weakly adhered microorganisms. After washing, each specimen was transferred to 12 x 145 mm tubes containing 2 ml of SSS and approximately 5 g of glass pearls (1–2 mm diameter). The tubes were submitted to shaking in a Vortex (AP56; Phoenix, São Paulo, Brazil) for 40 seconds and 20 µl were seed, in triplicate, in plates containing SDA. The plates were incubated at 37º C for 24 h. The colonies were counted and their number expressed in colony forming units per mm^2 of the specimen's surface area (CFU/ mm^2). There were realized three adherence assays in non-consecutive days.[15,16]

Statistical analysis

The arithmetic means results of water sorption, solubility, surface roughness and *Candida albicans* adherence were statistically analyzed using the program BioEstat® (version 4.0; UFPA, Belém, Brazil), using 1-way analysis of variance (ANOVA) for comparison, and the means were compared using the Tukey test. The adopted level of significance was $P < 0.05$ and maximum error permitted was 3%.

RESULTS

The 1-way ANOVA results for water sorption, solubility, surface roughness and *Candida albicans* adherence are expressed in Table II. The results showed significant differences between the groups A and B; B and D; C and D to water sorption, where Group D showed the highest values, followed by Group A. (Table III and Graph 1). The solubility results showed the Group D has statistically significant higher percentage than the other groups (Table III and Graph 2).

For surface free roughness, the results showed differences in all groups tested (Table III and Graph 3). The Figure 1 illustrates the scanned images obtained of each group tested and Figure 2 shows the 3D reconstructions.

The *Candida albicans* adhesion results did not show statistically significant differences between all groups tested (Table III and Graph 4).

DISCUSSION

Polymethyl metacrylate is characterized for be resistant and to have good optical properties and dimensional stability.[6] However, this material also has undesirable properties and porosity is the most. Porosity is attributed to various factors, including: air entrapped during mixing, monomer contraction during polymerization, monomer vaporization associated with the exothermic reaction, and the presence of residual monomer.[5] The major consequences of porosity are water sorption and solubility that may cause prejudicial defects in structure and functions of acrylic resins.[17]

The results showed that water sorption happens principally in the first 24 hours, tending to stabilize and remain constant until the 8th day (Graph 5). The heat-cured acrylic resin (Group D) has a higher water sorption percentage in comparison to the other groups. The solubility results also showed higher values of percentage to Group D. This may be justified by the differences between heat- and microwave-polymerized resin. Heat-cured acrylic resin is formed through the interaction of methyl methacrylate molecules that form a structure with simple polymeric chains of linear configuration, with a larger volume of interstitial matrix, the area of water molecule penetration. The fact of having simpler structure of polymeric chains, joined by more fragile unions, increases the susceptibility of breaking these unions, with fluids entering and releasing non-reacted substances.[5,6] High water sorption index of this resin in the first storage period corroborates this fact, which coincides with the residual monomer releasing apex. However, microwave-polymerized acrylic resin possesses crosslink agents in its composition that changes its reaction, formatting more tight, complex and interlaced chains, and also longer polymeric chains by the presence of co-polymers, leading to a less voluminous interstitial matrix. It does not give the opportunity for water molecules to enter in quantity and velocity as great as heat-polymerized resin. Crosslink agents also exert influence on these results.[5,6] Heat-polymerized resin does not have these agents and their presence in the acrylic resin composition leads to decreasing solubility, with this tendency becoming higher with the increase of its concentrations.[18]

Despite of that, only comparing the microwave-polymerized groups, the Group A has higher water sorption percentage than Groups B and C, showing the polymerization protocol also can influence this characteristic. Studies have related that polymerization cycles with lower voltages produce less porosity than higher voltages cycles.[19]

The results of atomic force microscopy showed an influence of the type and the polymerization protocol in the surface roughness of acrylic resin. The Group D obtained statistically minor Ra values in comparison with the other groups. In despite, just considering the microwave-polymerized resin groups, the results showed the polymerization protocol has influence in surface roughness. The Group B (shorter polymerization protocol) has lesser Ra values than the Groups A and C. The similar studies found in literature had not found significant differences in surface roughness of acrylic resins with different polymerization protocols, but these studies used other methodologies to measure surface roughness, like the use of a perfirometer.[3,20] While the perfirometer has a 0,01µm resolution, the atomic force microscopy used in this study can make measurements in nanometer scale.

However, the differences in water sorption, solubility and surface roughness did not cause statistically significant differences in *Candida albicans* adhesion. This result is in agreement with the results found by Moura in similar study[1]. However, there is not a standardized method to polymer microorganism adhesion assays. The most widely applied techniques are by optical count of the microorganisms per field, or via labeling with radioactive elements such as methionine or uridine, for subsequent count by scintillation camera. Other less widely used systems are counts under electronic microscope, or assessment of the growth capacity of colonies after serial dilutions, by Colony Forming Units (CFU) count. Even if the same system were used, the absence of an established protocol means that research groups use different *C albicans* strains, yeast concentrations, time and temperature conditions, procedures for removal of unattached yeast, and staining methods.[15,16,21] The CFU counting used in this study has the advantage about the other systems to allow only the count of live yeasts.

CONCLUSION

Within the limitations of this study the following conclusion were drawn:

1. Heat- and microwave-polymerized acrylic resins have differences in their physical properties of water sorption, solubility and surface roughness.

2. The microwave-polymerization protocol also can influence the water sorption and surface roughness properties of microwave-polymerized acrylic resin.
3. The differences found have no influence in *Candida albicans* adhesion to all the acrylic resins tested.

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Table I – Materials used for acrylic resin specimens fabrication.

Group	*Material (manufacturer)*	*Composition*	*Polymerization Protocol*
A	Onda Cryl (Artigos Odontológicos Clássico Ltda; São Paulo, Brazil)	Powder: methyl methacrylate copolymer, ethacrylate, dibutil paleoteodine, benzoyl peroxide. Liquid: methyl methacrylate, topanol, dimethyl methacrylate ethylenic glycol (EGDMA).	Microwave: 3 minutes at 360W + 4 minutes at 0W + 3 minutes at 810W
B	Onda Cryl (Artigos Odontológicos Clássico Ltda; São Paulo, Brazil)	Powder: methyl methacrylate copolymer, ethacrylate, dibutil paleoteodine, benzoyl peroxide. Liquid: methyl methacrylate, topanol, dimethyl methacrylate ethylenic glycol (EGDMA).	Microwave: 3 minutes at 540W
C	Onda Cryl (Artigos Odontológicos Clássico Ltda; São Paulo, Brazil)	Powder: methyl methacrylate copolymer, ethacrylate, dibutil paleoteodine, benzoyl peroxide. Liquid: methyl methacrylate, topanol, dimethyl methacrylate ethylenic glycol (EGDMA).	Microwave: 13 minutes at 90W (flask in vertical position) + 90 seconds at 540W (flask in horizontal position)
D	Clássico (Artigos Odontológicos Clássico Ltda; São Paulo, Brazil)	Powder: poly methyl methacrylate, dibutyl paleteodine, ethacrylate. Liquid: methyl metacrylate.	Hot water bath: 9 hours at 74ºC

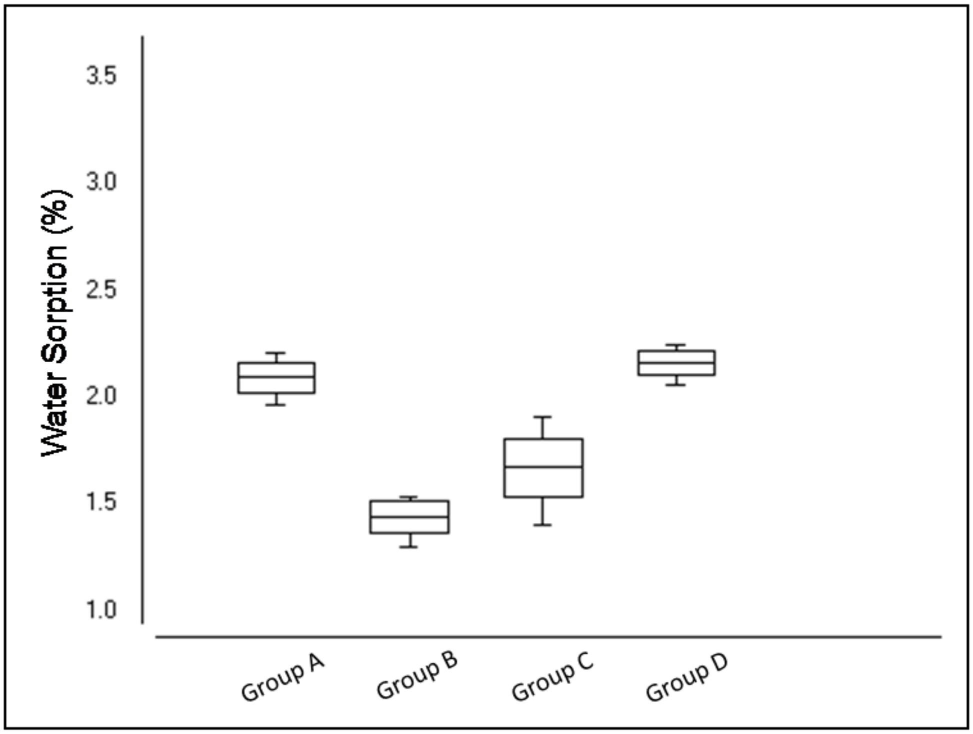
Table II – 1-way ANOVA for water sorption, solubility, surface roughness and *Candida albicans* adherence.

Variables	***Treatments***	***Sum of square***	***Mean square***	***F***	***P value***
Water sorption	3	1.749	0.583	141.363	0.0005
Solubility	3	0.406	0.135	69.408	0.0061
Surface roughness	3	86.253	28.706	218.811	< 0.0001
C. albicans adhesion	3	69.199	23.066	34.093	0.0003

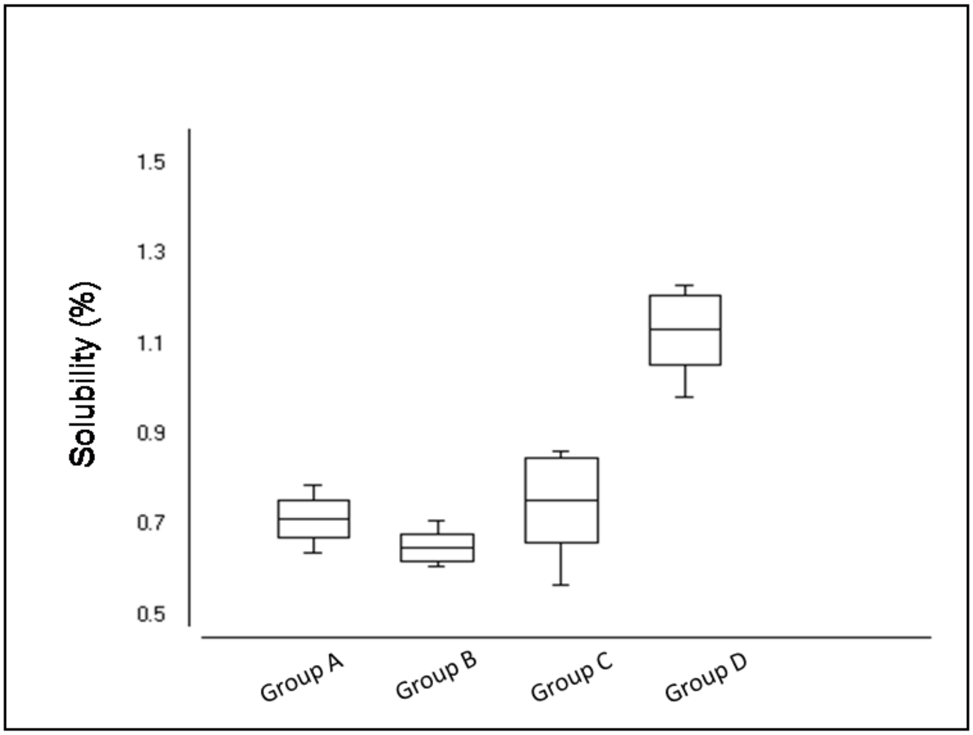
Table III – Mean and standard deviation for water sorption, solubility, surface roughness and *Candida albicans* adherence of the groups tested.

Group	Water sorption (%)	Solubility (%)	Surface roughness – Ra (ηm)	*C. albicans* adhesion (CFU/mm^3)
A	1.95 (± 0.14) a	0.71 (± 0.07) a	37.057 (± 20,145) a	12.31 (± 8.37) a
B	1.35 (± 0.16) b	0.65 (± 0.05) a	28.705 (± 6.363) b	6.66 (± 4.51) a
C	1.59 (± 0.09) ab	0.63 (±0.16) a	46.620 (± 16.900) a	6.52 (± 2.35) a
D	2.16 (± 0.09) a	1.02 (±0.14) b	8.636 (± 2.066) c	5.49 (± 5.38) a

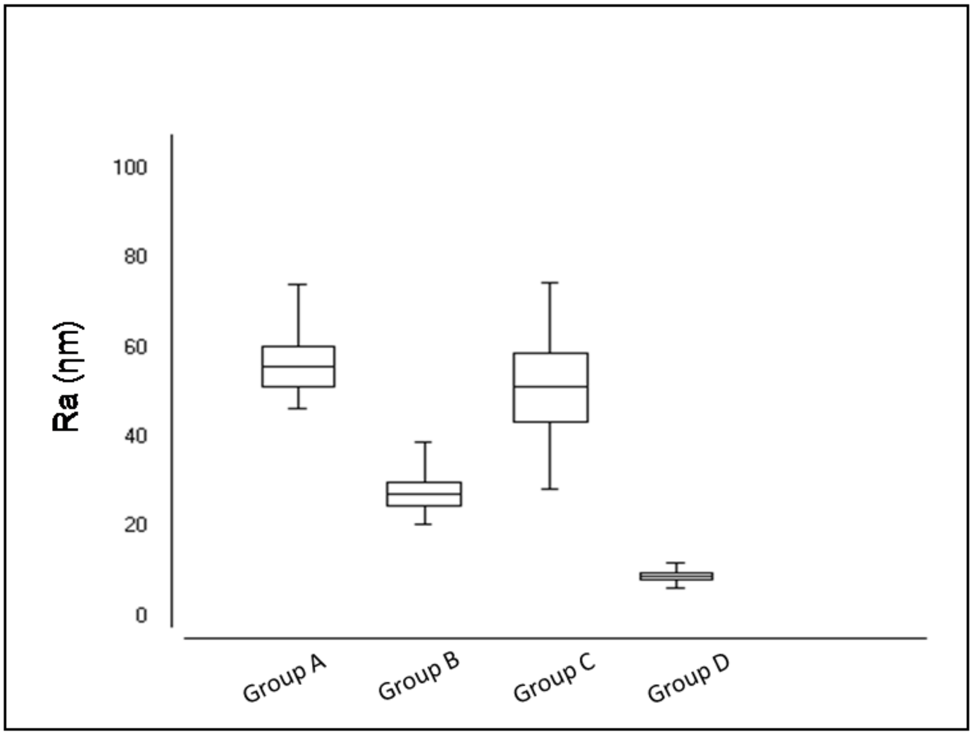
Mean values followed by separate letters are statistically different (P < 0.05).



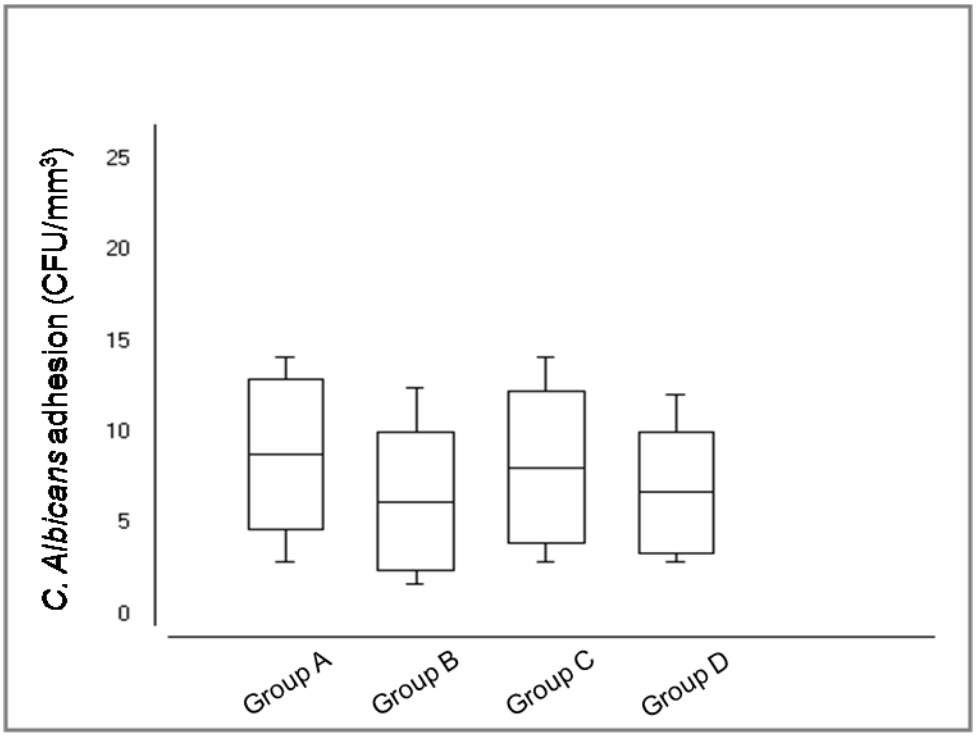
Graph 1 – Box-plot is illustrating the water sorption percentage values of acrylic specimens (n=4 per group). For all groups tested, the horizontal bar into the box indicates the mean value. The box indicates +1 and -1 standard deviation and the vertical lines indicate the minimum and the maximum values.



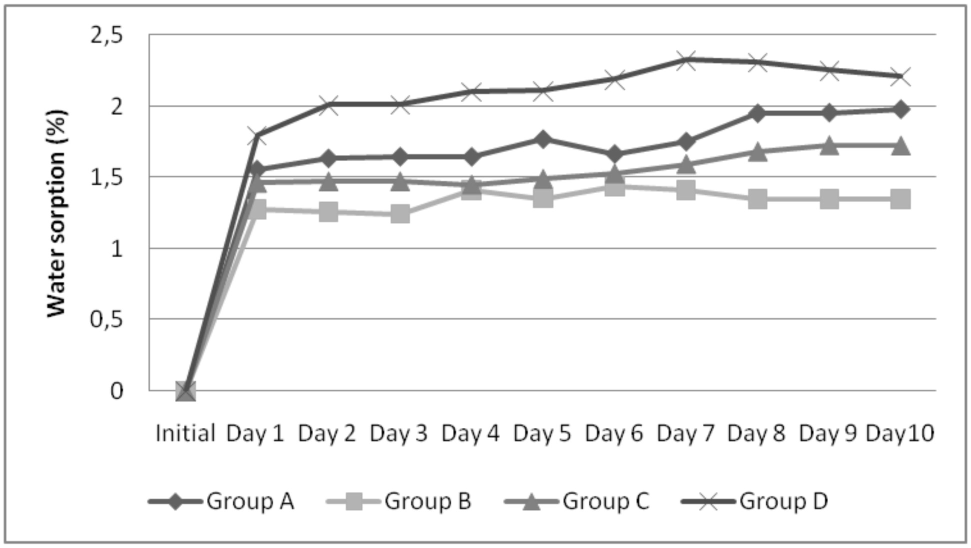
Graph 2 – Box-plot is illustrating the solubility percentage values of acrylic specimens (n=4 per group). For all groups tested, the horizontal bar into the box indicates the mean value. The box indicates +1 and -1 standard deviation and the vertical lines indicate the minimum and the maximum values.



Graph 3 – Box-plot is illustrating the surface roughness – Ra measured in nanometer of acrylic specimen (n=6 areas per group). For all groups tested, the horizontal bar into the box indicates the mean value. The box indicates +1 and -1 standard deviation and the vertical lines indicate the minimum and the maximum values.



Graph 4 – Box-plot is illustrating the *Candida albicans* adherence results, expressed in Colony Forming Unit (CFU) per cubic millimeter of acrylic specimen (n=9 per group). For all groups tested, the horizontal bar into the box indicates the mean value. The box indicates +1 and -1 standard deviation and the vertical lines indicate the minimum and the maximum values.



Graph 5 – The graph shows the daily evolution of water sorption percentages of acrylic specimen (n=4 per group).

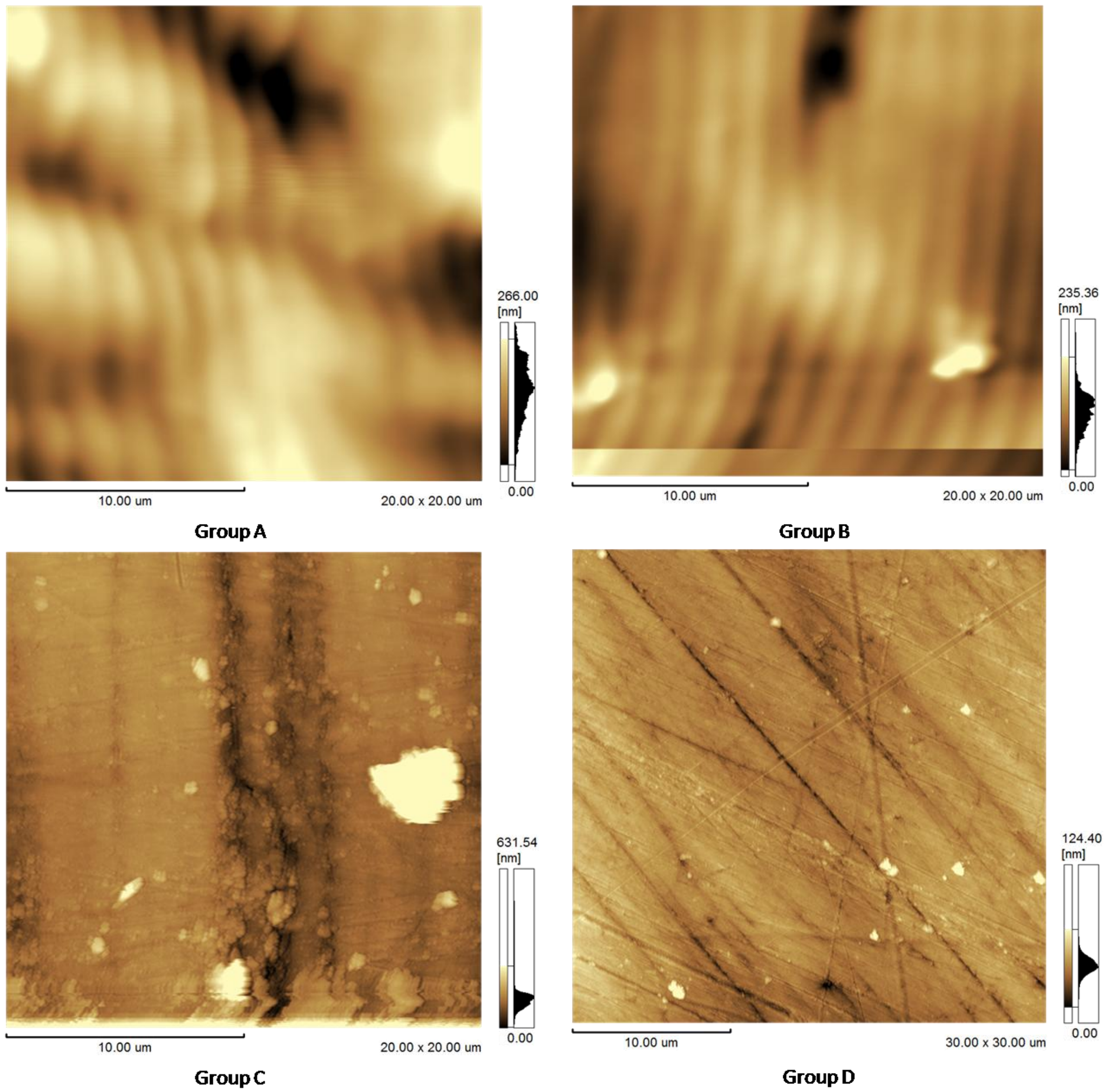


Image 1 – 20.00 x 20.00µm images illustrating the AFM scanning of the acrylic resin specimens. For measurement, three sub-areas with 10 x 10µm were used of 2 specimen of each group studied.

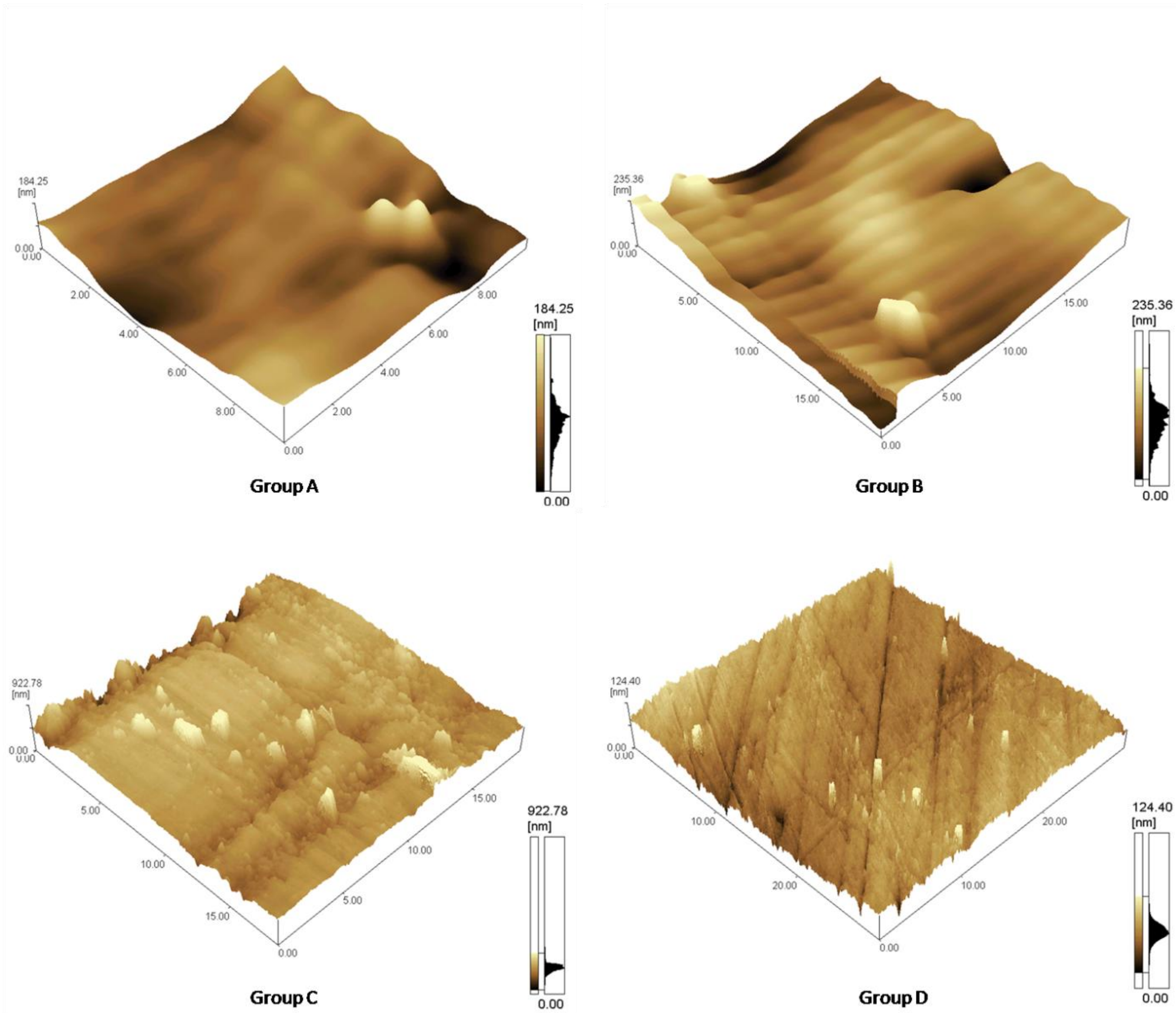


Image 2 – 3D illustrative reconstructions of AFM scanning acrylic resin specimens. For measurement, three sub-areas with 10 x 10µm were used of 2 specimen of each group studied.

5. CONSIDERAÇÕES FINAIS

Com base nos resultados obtidos, pode-se concluir que o método de polimerização das resinas acrílicas influi nas suas propriedades físicas. O PMMA polimerizado por energia de microondas possui diferenças em relação ao PMMA tradicional quando se comparam absorção de água, solubilidade e rugosidade superficial. Além disso, diferentes ciclos de polimerização por microondas causaram alterações na rugosidade superficial das resinas. Entretanto as diferenças encontradas não influenciaram a adesão de *Candida albicans.*

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