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INTERNAL ADAPTATION OF CUSP-WEAKENED CLASS I RESTORED WITH BULK-FILL, BI-LAYERED AND INCREMENTAL RESTORATIVE TECHNIQUES: A micro-CT ANALYSIS

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Dissertação apresentada ao Programa de Pós-Graduação em Odontologia da Pontifícia Universidade Católica do Paraná, como parte dos requisitos para obtenção do título de Mestre em Odontologia, Área de Concentração em Clínica Odontológica Integrada (Ênfase em Dentística)

Orientador: Profª. Drª. Evelise Machado de Souza

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Title: INTERNAL ADAPTATION OF CUSP-WEAKENED CLASS I RESTORED WITH BULK-FILL, BI-LAYERED AND INCREMENTAL RESTORATIVE TECHNIQUES: A micro-CT ANALYSIS

Short Title: micro-CT ANALYSIS OF INTERNAL ADAPTATION OF CUSP-WEAKENED CLASS I RESTORATIONS

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Abstract

The aim of the present study was to evaluate the internal adaptation of composite restorations in cusp-weakened extensive Class I preparations restored with incremental, bi-layered and bulk-fill techniques using a microcomputed tomography analysis (micro-CT). Standardized cusp-weakened class I preparations were performed in 60 caries-free human third molars that were randomly divided in six groups, according to the resin composite and adhesive system used (n=6): 1) FI = Single Bond Universal + Filtek Supreme XT; 2) FF = Single Bond Universal + Filtek Bulk Fill Flowable + Filtek Bulk Fill Posterior; 3) FB = Single Bond Universal + Filtek Bulk Fill Posterior; 4) GI = Futurabond U + GrandioSO; 5) GF = Futurabond U + X-tra Base Bulk-fill flowable + GrandioSO; 6) GB = Futurabond U + Admira Fusion X-tra. The remaining two groups were restored with conventional nanofilled and nanohybrid composites using incremental oblique technique. All teeth were subjected to thermocycling (20,000 cycles, 5°C and 55°C) and mechanical loading (250,000 cycles, 2.5 Hz, 50N) before the analysis of internal adaptation by micro-CT. The percentage and volume of internal gaps were analyzed by one-way ANOVA and Games-Howell test ($p<.05$). Results: The incremental and bi-layered techniques using the nanofilled conventional composite showed significantly less internal gaps when compared with the incremental technique with a nanohybrid conventional composite ($p<.05$).There were not found significant differences among the other groups ($p>.05$). Conclusion: Nanofilled composites demonstrated higher internal adaptation than nanohybrid composites when used in bulk and incrementally.

Clinical significance: Bulk-fill composites can be recommended for cusp-weakened Class I restorations since they endeavor to simplify clinical procedures and to reduce steps and treatment times are promising.

Introduction

Composite resins are the first-choice materials for direct posterior restorations due to its aesthetic results, ability to bond to the tooth structure, low cost and adaptation into different types of preparations.[1] However, clinical studies have shown that the main reasons for failure in posterior restorations are tooth fracture, secondary caries and occlusal wear, as a result of high occlusal-stress and incidence of masticatory forces.[2,3]

In the last decade, bulk-fill composites have been developed and investigated for posterior restorations.[4] Besides being able to simplify the clinical steps allowing cavity filling in a single increment, the main features of these composites are the increased degree of cure,[5,6] low polymerization shrinkage,[7,8] lower cuspal deflection,[8] low elastic modulus[9] and reduced chair side time.[10] The bulk-fill composites are available in different viscosities according to their indications for use. Full-body bulk-fill composites are more viscous and adaptable materials indicated for Class I and Class II preparations.[11] Bulk-fill flowable composites are low-viscosity materials recommended for pit and fissure sealing, Class III and V restorations, restoration of minimally invasive cavity preparations, repair of small defects in enamel and indirect restorations and base under Class I and II direct.[11] Due to its low viscosity, bulk-fill flowable composites present easy handling and good adaptation to the inner walls of the cavity preparation.[9] Bulk-fill flowable composites usually have less filler content when compared with full-body bulk-fill and conventional composites[9,12] leading to lower wear resistance.[6]

Cavity configuration (C-factor) is higher in Class I preparations, where there are five bonded walls and only one free surface.[13] Due to polymerization shrinkage of resin-based composites, the higher C-factor of deep Class I cavities induces to a large amount of stress in the adhesive interface.[14] In this type of cavity, the stress release is restricted to only one free surface, which increases the stress inside the cavity and at the adhesive interface.[14] When polymerization shrinkage stress exceeds bond strength, the adhesive failures produce gaps in the interface[15] resulting in post-operative sensitivity, marginal discoloration and secondary caries.[16] In this way, the use of liners can play a vital role in minimizing polymerization shrinkage stress by the elastic bonding concept and increase the longevity and favorable outcome for composite restorations.[17] Also, the use of a liner with a low viscosity could provide better cavity adaptation, less gap formation and work as a stress-absorbing layer at the tooth-restoration interface.[18]

Internal adaptation of composite restoration has been investigated by micro-computed tomography (micro-CT) analysis.[20-22] This equipment uses X-rays to create cross 102 sections of a 3D object that can be used to recreate a virtual model with a spatial 103 resolution at a micron level without destroying the original specimen. The detection and quantification of the internal gaps are performed by 2D and 3D micro-CT scans.[20,21] This method is characterized by its non-destructive nature,[20,23] allowing repeated evaluation of the same specimen[24] and high accuracy.[21]

Most of previous studies on internal adaptation determined the amount or percentage of gaps inside Class II MOD preparations.[24-27] Fewer studies focused on the internal adaptation of bulk-fill composites in Class I preparations.[22,28,29] In addition, extensive and cusp-weakened Class I restorations are considered a challenge to the clinician since they have a high C-factor and are subjected to stress-bearing occlusal forces. Also, in deep preparations the inner portions are difficult to reach and to adapt the restorative material properly.[30]

Therefore, the aim of the present study is to evaluate the internal adaptation of composite restorations in cusp-weakened extensive Class I preparations using bulk-fill composites compared to conventional composites with and without the use of a flowable base by a micro-CT analysis. The hypothesis to be tested is that there will be no difference in the internal adaptation of restorations with different restorative techniques.

Material and Methods

Preparation of specimens

Sixty sound human third molars were obtained after the approval of the research protocol by the Local Ethics Committee (2.824.728). Soft tissues and calculi were removed with periodontal curettes and the teeth were stored in chloramine 0.5% at 4ºC. The criteria for the selection of teeth were absence of caries, cracks or fractures, and a similar crown size and intercuspal length.

Class I occlusal preparations were performed by a single operator using rounded diamond burs (#1016, KG Sorensen, Cotia, SP, Brazil) and cuspal weakening was performed by a pear-shaped diamond bur (#3168, KG Sorensen, Cotia, SP, Brazil) using a high-speed handpiece under water cooling. The burs were replaced every five preparations. The depth of the occlusal box was set at 4 mm, while the buccal-lingual width was set at ¾ of the intercuspal distance, checked with a digital caliper (150mm/6" CD-6" CSX-B Digital Caliper, Mitutoyo, Miyazaki, Japan).

A simulation of the periodontal ligament was carried out by covering the roots with melted wax and embedding these roots in self-curing acrylic resin within polyvinyl chloride tubes (25 mm diameter and 35 mm height). The exothermic reaction of the acrylic resin polymerization allowed the teeth to be displaced so that the wax surrounding the root was easily removed. After that, each tooth was repositioned in the formed acrylic slot. After cooling and final polymerization of the self-curing acrylic resin, the teeth were removed and a polyether-based impression material (Impregum Polyeter Impression Material, 3M ESPE, St. Paul, MN) was dispensed inside the slot, and the teeth were positioned. After setting, the excess material was removed with a scalpel blade.

Restorative procedures

The teeth were randomly divided into six groups with 10 teeth each. The compositions of the resin composites used in the study are described in Table 1.

Table 1: Description of the composites used in the study.

Material (Manufacturer)	Type	Resin matrix	Filler particles	Filler content (%) wt/vol
Filtek Bulk Fill Flowable (3M ESPE)	Bulk-fill flowable composite	BisGMA, UDMA, BisEMA, Procrylat	Zirconia/sílica, ytterbium trifluoride	64.5% / 42.5%

Filtek Bulk Fill Posterior (3M ESPE)	Bulk-fill composite	AUDMA, UDMA, DDMA, AFM dimethacrylates	Zirconia/sílica nanofillers and nanocluster, ytterbium trifluoride	76.5% / 58.4%
Filtek Supreme Ultra (3M ESPE)	Nanofilled composite	BisGMA, UDMA, TEGDMA, PEGDMA, BisEMA	Zirconia/sílica nanofillers and nanocluster, ytterbium trifluoride	78.5% / 63.3%
X-tra Base (VOCO)	Bulk-fill flowable composite	BisGMA, BisEMA, UDMA	Barium glass, ytterbium trifluoride, fumed silica	75% / 58%
Admira Fusion X-tra (VOCO)	Bulk-fill restorative material	ORMOCER®: inorganic-organic hybrid polymers	Glass ceramic and silicone dioxide	84% / N.I.
GrandioSO (VOCO)	Nanohybrid composite	BisGMA, BisEMA, TEGDMA	Glass ceramic and silicone dioxide	89% / 73%

Abbreviations: BisGMA: bisphenol-A-diglycidyl-dimethacrylate; UDMA: urethane dimethacrylate; Bis-EMA: ethoxylated bisphenol A dimethacrylate; Procrylat: 2,2-bis[4-(3-methacryloxypropoxy)phenyl]propane; AUDMA: aromatic urethane dimethacrylate; DDMA: 1, 12-Dodecanediol dimethacrylate; AFM: addition-fragmentation monomer; TEGDMA: triethyleneglycol dimethacrylate; PEGDMA: polyethylene glycol dimethacrylate; MDP: 10-methacryloyloxydecyl dihydrogen phosphate; HEMA: 2-hydroxyethyl methacrylate; HEDMA: hydroethyl dimethacrylate; N.I.: not informed.

Table 2 shows the distribution of the experimental groups of the study. The adhesive procedure for all the teeth was performed with two universal adhesives in the same brand as the composites: Single Bond Universal (3M ESPE, St. Paul, USA) and Futurabond U (VOCO, Cxh, Germany). The selective enamel etching technique was carried out using a 37% phosphoric acid (Ultradent Products, South Jordan, UT) applied for 30 s, followed by water rinsing for 15 s and air drying for 1-2 s. The adhesive was rubbed onto the etched enamel and untreated dentin surfaces for 20 s, followed by air drying for 5 s, and light-curing for 10 s.

Table 2: Distribution of the experimental groups of the study (n = 10).

Group	Adhesive System	Base	Composite Resin
FI	Single Bond Universal	-	Filtek Supreme XT Universal Restorative
FF	Single Bond Universal	Filtek Bulk Fill Flowable Restorative	Filtek Supreme XT Universal Restorative

FB	Single Bond Universal	-	Filtek Bulk Fill Posterior Restorative
GI	Futurabond U	-	GrandioSO
GF	Futurabond U	X-tra Base Bulk-fill flowable composite	GrandioSO
GB	Futurabond U	-	Admira Fusion X-tra

In FF and GF groups, bulk-fill flowable composites were inserted in a 3 mm-single increment, followed by light-curing for 20 s. A 1mm-thick layer of conventional composite was placed over the previously inserted flowable base using an incremental oblique technique followed by 20 s light-curing for each increment. Teeth of groups FB and GB were restored with bulk-fill full-body composites inserted in a 4mm-thick increment and light-cured for 40 s. Teeth of FI and GI groups were restored with conventional composites using oblique increments up to 2mm-thick and light-cured 20 s each. All the light activations were performed as close as possible to the material, with a high-irradiance (1000 mW/cm^2) LED curing unit (VALO® Cordless, Ultradent Products, South Jordan, UT).

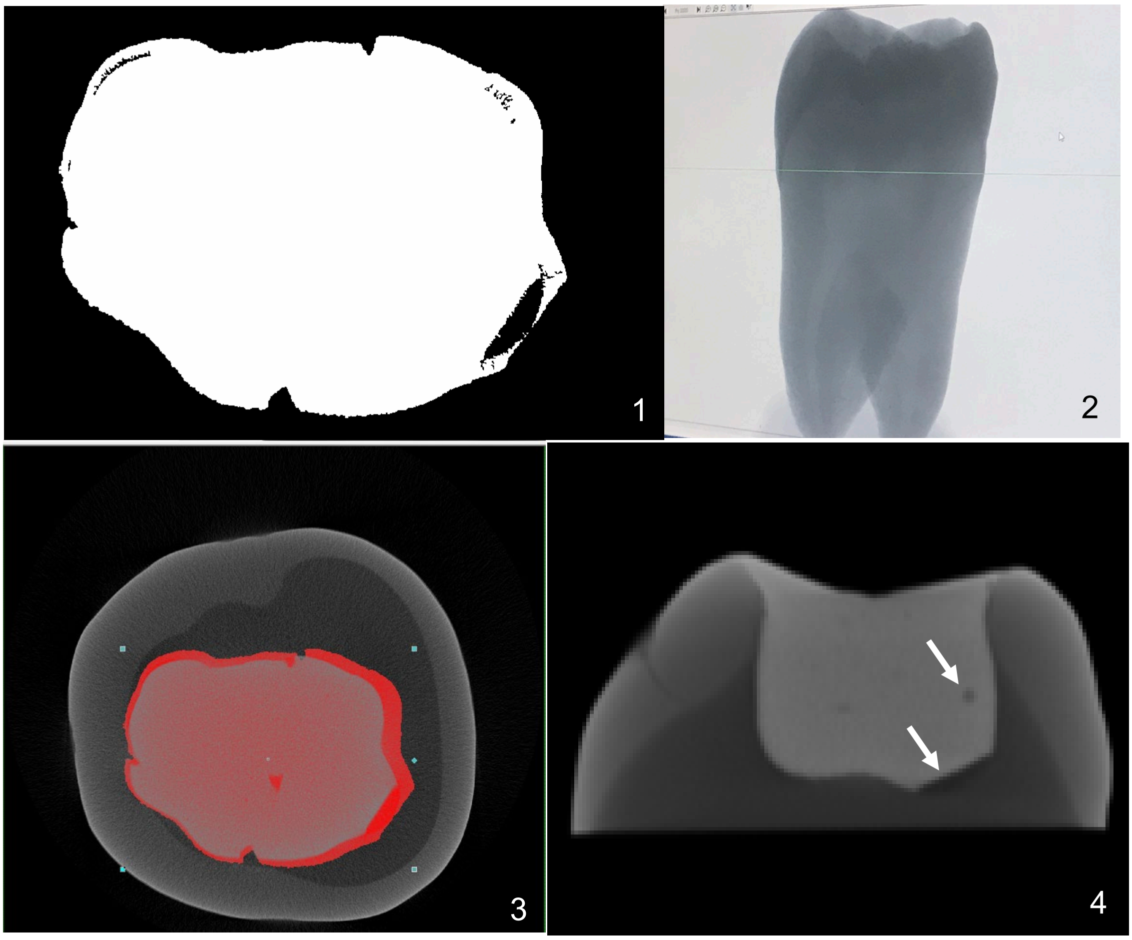
Thermocycling and mechanical fatigue loading procedures

The specimens were submitted to 20,000 cycles of thermocycling at 5ºC and 55ºC with a dwell-time of 15 s (OMC 250, Odeme Dental Research, Luzerna, SC, Brazil). The specimens were subjected to mechanical load cycling for 250,000 cycles at a 2.5-Hz frequency and 50N load (Biocycle, Biopidi, São Carlos, SP, Brazil). The apparatus consisted of 10 steel pistons performing axial movements to the center of the occlusal surface of each sample. During all mechanical load cycling, the specimens were kept immersed in distilled water at 37ºC. The test was considered complete until reaching the maximum number of cycles or until the specimen fracture. After the thermomechanical procedures, the specimens were stored in distilled water for 24 h at 37ºC.

Analysis of internal adaptation by micro-CT

The analysis of the internal adaptation was carried out by a high-resolution 3D X-ray microtomography system (SkyScan 1172, Bruker MicroCT, Kontich, Belgium) connected to a data network acquisition system and control computer (host) for image reconstruction. The micro-CT images were taken using 89 kV mean acceleration voltage, 112 µA mean current, 12µm pixel image size, 0.5mm aluminum filter, 2 s exposure time and 0.5° rotation step. Each tooth was mounted on a specially designed jig for standardized imaging.

After acquisition, the images were transferred to NRecon (Micro Photonics, Allentown, PA, USA) (Figure 1) software in order to reconstruct the radiographic images in three-dimensional images. The interest area was considered from the top of the cusp until the bottom of the restoration. The parameters (ring artifacts reduction, beam-hardening, smoothing) were set up to properly reconstruct the images with the less effects possible. The 3D images were transferred to the CTAnalyser software (Bruker Corporation, Billerica, MA, USA) in which the bottom and top of the interest area were identified, considering the whole extension of the restoration (Figure 2). CTAnalyser was used to differentiate the substrates, as dentin, restoration and internal gaps at the bonding interface. In this step, volume and percentage were set as unit measures of the internal gaps found in the images (Figure 3). For 3D visualization of the restoration, internal gaps and the presence of voids was possible by transferring the images to CTvox software (Figure 4).



Figures: 1) Three-dimensional image of a specimen using the NRecon software. 2) Selection of the interest area using the CTAnalyzer software. 3) Binarization of the image for the distinction of dentin, restoration and internal gaps.
4) 3D image of a specimen acquired by CTvox software. The pointers demonstrate internal gap and voids.

Statistical Analysis

The data of percentage and volume of internal gaps were analyzed for normality of distribution by the Kolmogorov-Smirnov test and for homogeneity of variance by the Levene’s test. One-way ANOVA and Games-Howell test were used to detect differences among groups. All the tests were performed with a 5% significance level using SPSS 24.0 software (SPSS Inc., Chicago, IL, USA).

Results

The results of the data in percentage and volume of internal gaps are presented in Table 3. ANOVA demonstrated significant differences among the restorative strategies both in volume ($p=0.002$) and in percentage of gaps ($p=0.005$). FF ($p=0,01$) and FI ($p=0,03$) groups in which teeth were restored with the nanofilled conventional composite with and without the flowable base showed statistically less internal gaps when compared with GI group in which the teeth were restored with the nanohybrid conventional composite without base ($p<0.05$). The remaining comparisons among the groups showed no significant differences ($p>0.05$).

Table 3: Mean and standard deviation of volume (mm^3) and percentage (%) of internal gaps in the study groups.

Groups	**Volume** Mean ± SD	**Percentage** Mean ± SD	**Sig**
FI	0.98 ± 0.60	1.52 ± 0.63	a
FF	0.97 ± 0.49	1.74 ± 0.37	a
FB	2.12 ± 1.33	2.55 ± 1.31	ab
GI	1.89 ± 0.57	2.70 ± 0.74	b
GF	1.36 ± 0.43	1.92 ± 0.42	ab
GB	1.51 ± 0.46	2.11 ± 0.58	ab

Different letters indicate significant differences between the groups for both volume and percentage ($p<0.05$).

Discussion

This study investigated the internal adaptation of extensive Class I preparations restored with nanofilled and nanohybrid conventional and bulk-fill composites by micro-CT analysis. The null hypothesis of the study was rejected since differences were found between some of the experimental groups.

Composite restorative materials undergo significant volumetric shrinkage during light-curing.[31] When polymerization shrinkage stresses exceed dentin bond strength the adhesive failure may produce gaps in the bonded interface.[15] The incremental technique was developed to compensate for these stresses by reducing the composite volume with small increments.[33] Additionally, the increments must be placed obliquely, reducing the contact area with the cavity walls during polymerization.[34] Differently, bulk-fill composites have been developed to allow the cavity filling in one single increment and to reduce some drawbacks of conventional composites, such as polymerization shrinkage[35,36] and gap formation.[19]

The differences in the filler content and type of monomers in the resin matrix are factors that affect the polymerization shrinkage[37] and consequently the formation of gaps. In the present study, the teeth restored with the nanohybrid composite without a flowable base presented higher percentage of gaps when compared to the nanofilled composite with the same strategy. The nanohybrid composite GrandioSO presents glass ceramics and silicon dioxide filler at 89% in weight and its organic matrix is composed by Bis-GMA, Bis-EMA and TEGDMA. Whereas the nanofilled composite Filtek Supreme, contains 78.5% of weight of silica and zirconia particles, clusters of aggregated particles of zirconia/silica and methacrylate monomers components of the organic matrix. Previous study demonstrated that the nanotechnology involved in this composite could lead to increased creep during shrinkage, allowing tension to be released and induce lower polymerization shrinkage.[38] Additionally, the type and the density of the inorganic fillers could also have led to lower polymerization shrinkage since zirconia fillers tend to absorb more energy and restrict crack propagation.[39]

A previous micro-CT analysis study demonstrated lower shrinkage polymerization of Filtek Supreme when compared to flowable materials.[12,22,40] Although the linear polymerization shrinkage of Filtek Supreme and GrandioSO are similar (1.36% and 1.6%, respectively), according to the manufacturers, the gap formation inside a Class I cavity preparation must be distinguished because of the polymerization shrinkage stress caused in the interface by the high configuration factor of the cavity preparation.[41]

An important outcome of the present study was the lack of difference in internal adaptation among the groups restored with conventional nanofilled and nanohybrid composites with flowable bases and bulk-fill composites alone.

Previous studies have shown that posterior restorations with bulk-fill composites produce lower cusp deflection,[8] lower shrinkage stress and higher fracture resistance than conventional composites.[42] However, there are still some studies that suggests that the incremental technique produces better internal adaptation than bulk-fill techniques and similar polymerization shrinkage.[19,30,35,36]

The nanohybrid full-body bulk-fill investigated in the present study present ORMOCER™ (organically modified ceramics) technology that is claimed by the manufacturer to be featured by large and precondensed molecules forming an inorganic matrix (silicon oxides and glass ceramic) with a high degree of cross-linking, reduced polymerization shrinkage and stress, as well as better adaptation to the cavity walls.[43] This restorative material demonstrated lower linear shrinkage when compared to other bulk-fill composites in a previous *in vitro* investigation[44] and demonstrated similar clinical performance when compared to a conventional composite of the same manufacturer.[45]

Bulk-fill flowable materials incorporates higher content of UDMA and Bis-GMA, producing less shrinking stress, without decreasing the conversion rate,[46,47] and significant reduced cuspal deflection.[8,48] In addition, they exhibit a reduction of the flexural modulus, resulting in better cavity adaptation,[49] also related to their lower shrinkage stress.[50] All these mechanical features make flowable materials act as a stress-absorbing intermediate layer in opposed to the high modulus of elasticity of the conventional composites.[18]

Since in the present study bulk-fill composites presented similar internal adaptation when compared to their incremental and bi-layered counterparts, they could be clinically recommended for extensive preparations based on the bulk build-up technique into 4-5mm thick single increment and reduced chair time. Flowable bulk-fill composites used as an intermediate base can also be considered as an alternative for deep preparations, since a conventional composite is used to cover and protect them from high stress-bearing occlusal loads. However, additional and long-term investigations are needed to elucidate the advantages of these restorative materials for different types of preparations.

Conclusion

Bulk-fill composites can be recommended for extensive Class I restorations since they performed similarly to the bi-layered technique using a flowable base covered by conventional composites. Also, nanofilled composites used alone and incrementally resulted in higher internal adaptation than nanohybrid composites.

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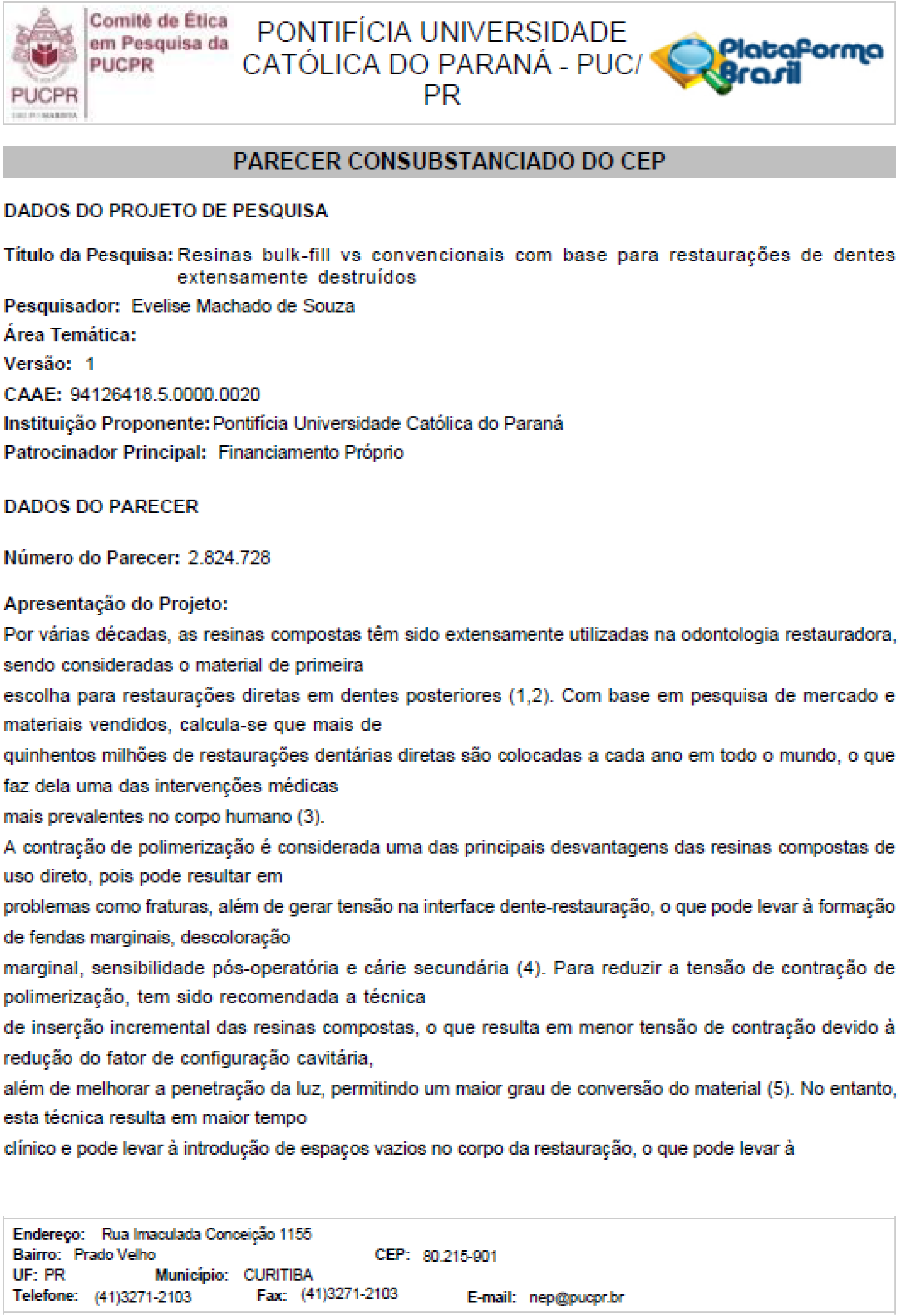
ANEXOS

Parecer de Comitê de Ética em Pesquisa



Comitê de Ética em Pesquisa da PUCPR

PONTIFÍCIA UNIVERSIDADE CATÓLICA DO PARANÁ - PUC/PR

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Resinas bulk-fill vs convencionais com base para restaurações de dentes extensamente destruídos

Pesquisador: Evelise Machado de Souza

Área Temática:

Versão: 1

CAAE: 94126418.5.0000.0020

Instituição Proponente: Pontifícia Universidade Católica do Paraná

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 2.824.728

Apresentação do Projeto:

Por várias décadas, as resinas compostas têm sido extensamente utilizadas na odontologia restauradora, sendo consideradas o material de primeira escolha para restaurações diretas em dentes posteriores (1,2). Com base em pesquisa de mercado e materiais vendidos, calcula-se que mais de quinhentos milhões de restaurações dentárias diretas são colocadas a cada ano em todo o mundo, o que faz dela uma das intervenções médicas mais prevalentes no corpo humano (3).

A contração de polimerização é considerada uma das principais desvantagens das resinas compostas de uso direto, pois pode resultar em problemas como fraturas, além de gerar tensão na interface dente-restauração, o que pode levar à formação de fendas marginais, descoloração marginal, sensibilidade pós-operatória e cárie secundária (4). Para reduzir a tensão de contração de polimerização, tem sido recomendada a técnica de inserção incremental das resinas compostas, o que resulta em menor tensão de contração devido à redução do fator de configuração cavitária, além de melhorar a penetração da luz, permitindo um maior grau de conversão do material (5). No entanto, esta técnica resulta em maior tempo clínico e pode levar à introdução de espaços vazios no corpo da restauração, o que pode levar à

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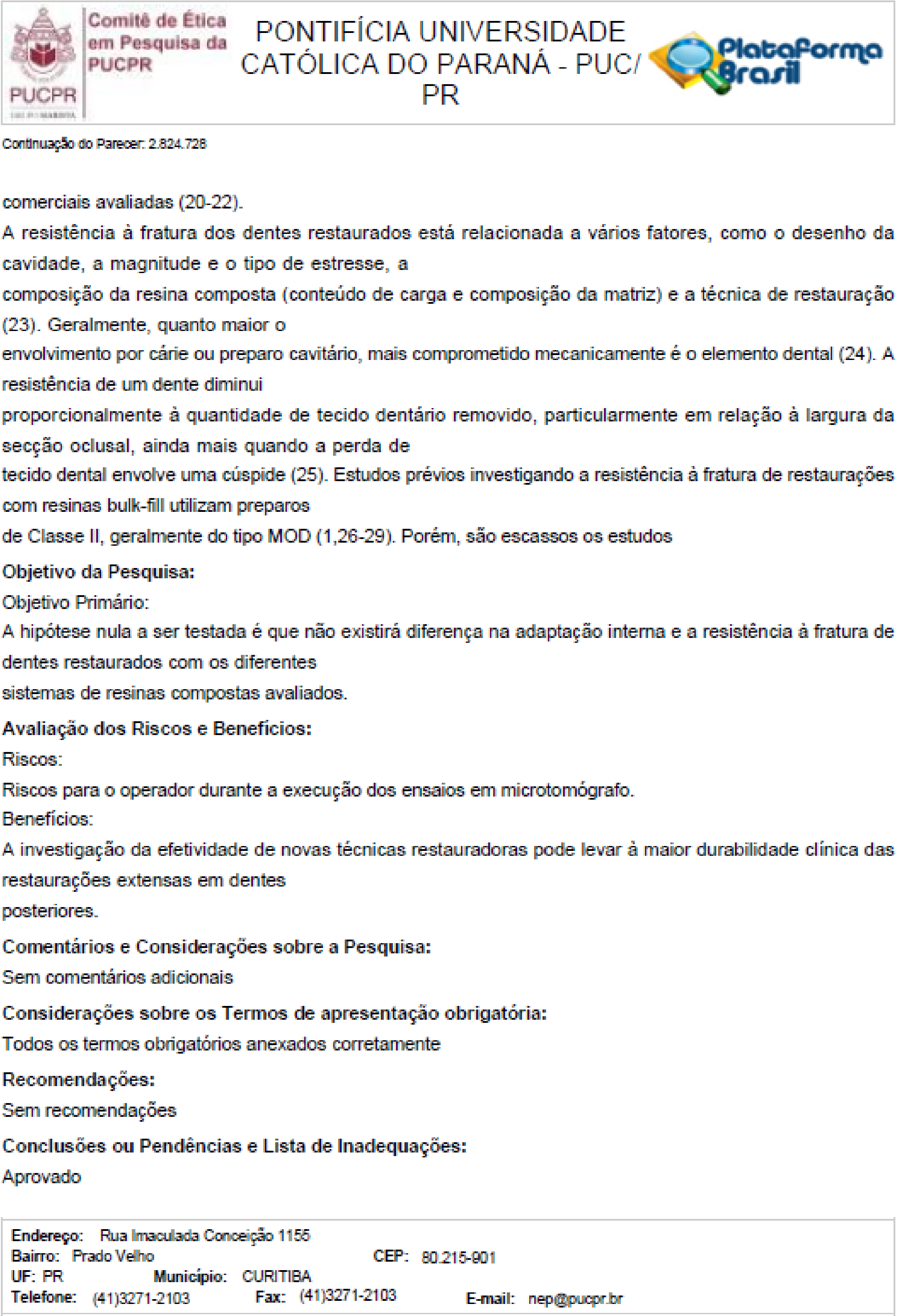

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Continuação do Parecer: 2.824.728

comerciais avaliadas (20-22).

A resistência à fratura dos dentes restaurados está relacionada a vários fatores, como o desenho da cavidade, a magnitude e o tipo de estresse, a
composição da resina composta (conteúdo de carga e composição da matriz) e a técnica de restauração (23). Geralmente, quanto maior o
envolvimento por cárie ou preparo cavitário, mais comprometido mecanicamente é o elemento dental (24). A resistência de um dente diminui
proporcionalmente à quantidade de tecido dentário removido, particularmente em relação à largura da secção oclusal, ainda mais quando a perda de
tecido dental envolve uma cúspide (25). Estudos prévios investigando a resistência à fratura de restaurações com resinas bulk-fill utilizam preparos
de Classe II, geralmente do tipo MOD (1,26-29). Porém, são escassos os estudos

Objetivo da Pesquisa:

Objetivo Primário:

A hipótese nula a ser testada é que não existirá diferença na adaptação interna e a resistência à fratura de dentes restaurados com os diferentes
sistemas de resinas compostas avaliados.

Avaliação dos Riscos e Benefícios:

Riscos:

Riscos para o operador durante a execução dos ensaios em microtomógrafo.

Benefícios:

A investigação da efetividade de novas técnicas restauradoras pode levar à maior durabilidade clínica das restaurações extensas em dentes
posteriores.

Comentários e Considerações sobre a Pesquisa:

Sem comentários adicionais

Considerações sobre os Termos de apresentação obrigatória:

Todos os termos obrigatórios anexados corretamente

Recomendações:

Sem recomendações

Conclusões ou Pendências e Lista de Inadequações:

Aprovado

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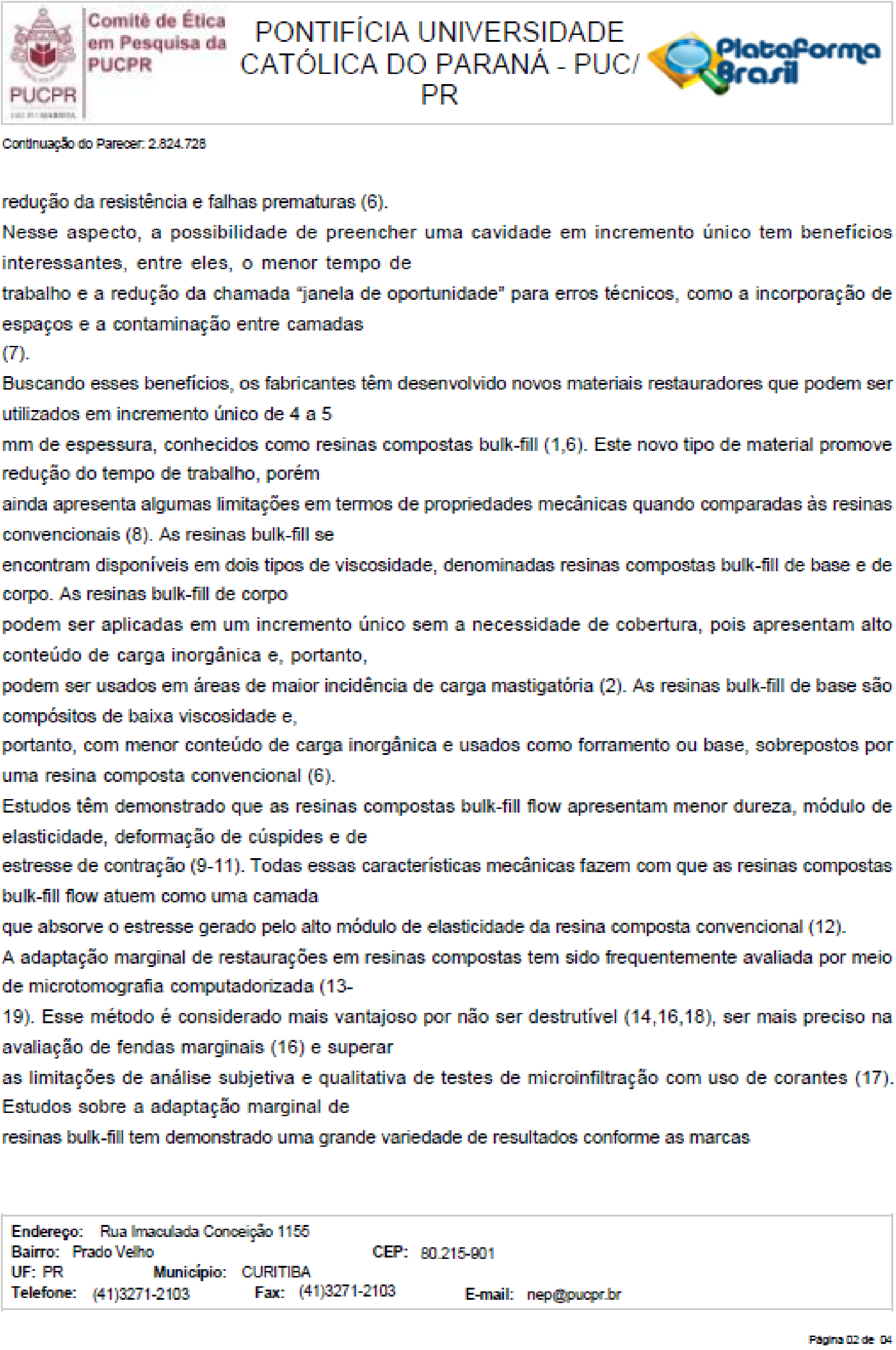


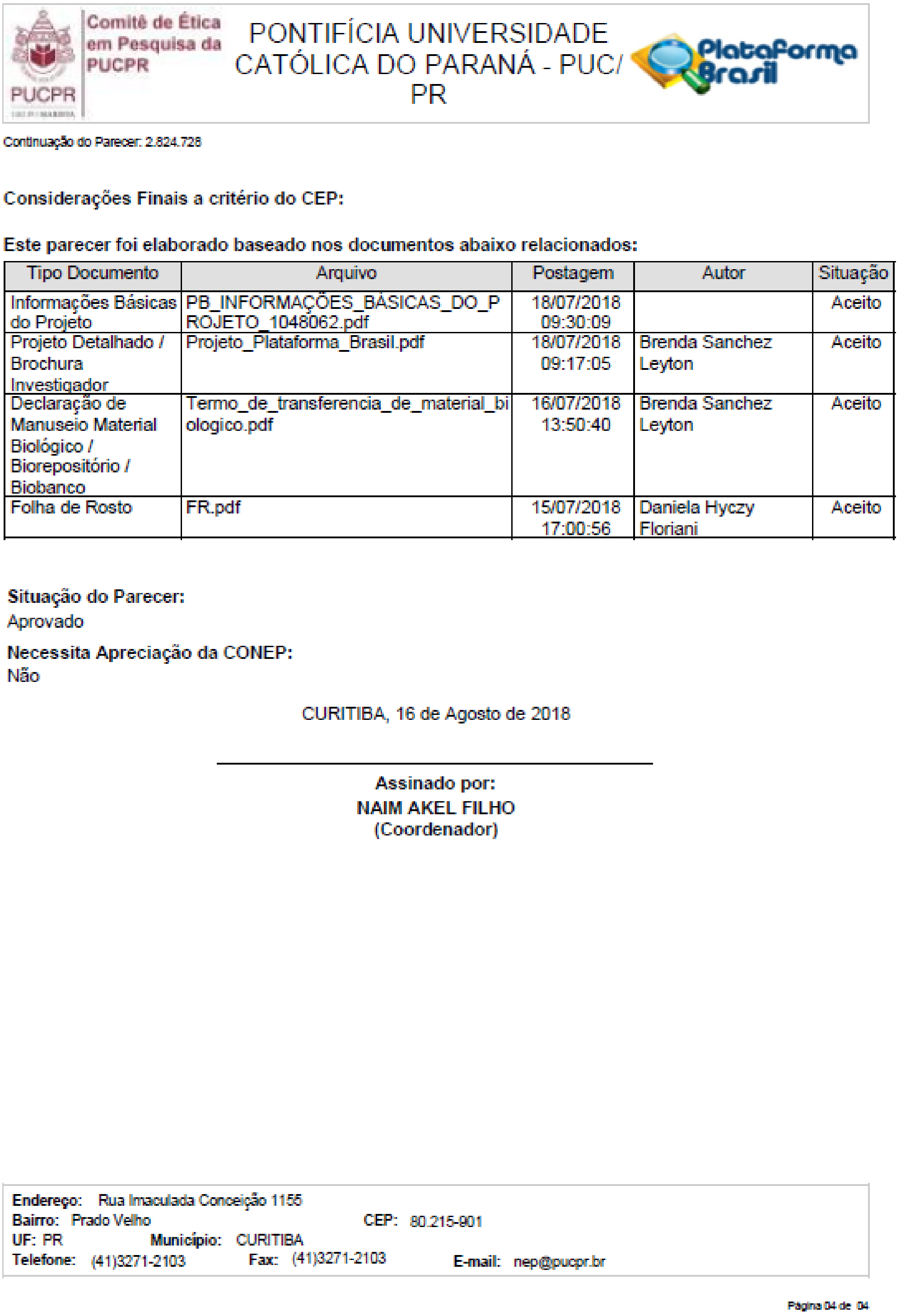
redução da resistência e falhas prematuras (6).

Nesse aspecto, a possibilidade de preencher uma cavidade em incremento único tem benefícios interessantes, entre eles, o menor tempo de trabalho e a redução da chamada "janela de oportunidade" para erros técnicos, como a incorporação de espaços e a contaminação entre camadas (7).

Buscando esses benefícios, os fabricantes têm desenvolvido novos materiais restauradores que podem ser utilizados em incremento único de 4 a 5 mm de espessura, conhecidos como resinas compostas bulk-fill (1,6). Este novo tipo de material promove redução do tempo de trabalho, porém ainda apresenta algumas limitações em termos de propriedades mecânicas quando comparadas às resinas convencionais (8). As resinas bulk-fill se encontram disponíveis em dois tipos de viscosidade, denominadas resinas compostas bulk-fill de base e de corpo. As resinas bulk-fill de corpo podem ser aplicadas em um incremento único sem a necessidade de cobertura, pois apresentam alto conteúdo de carga inorgânica e, portanto, podem ser usados em áreas de maior incidência de carga mastigatória (2). As resinas bulk-fill de base são compósitos de baixa viscosidade e, portanto, com menor conteúdo de carga inorgânica e usados como forramento ou base, sobrepostos por uma resina composta convencional (6).

Estudos têm demonstrado que as resinas compostas bulk-fill flow apresentam menor dureza, módulo de elasticidade, deformação de cúspides e de estresse de contração (9-11). Todas essas características mecânicas fazem com que as resinas compostas bulk-fill flow atuem como uma camada que absorve o estresse gerado pelo alto módulo de elasticidade da resina composta convencional (12).

A adaptação marginal de restaurações em resinas compostas tem sido frequentemente avaliada por meio de microtomografia computadorizada (13-19). Esse método é considerado mais vantajoso por não ser destrutível (14,16,18), ser mais preciso na avaliação de fendas marginais (16) e superar as limitações de análise subjetiva e qualitativa de testes de microinfiltração com uso de corantes (17). Estudos sobre a adaptação marginal de resinas bulk-fill tem demonstrado uma grande variedade de resultados conforme as marcas



Comitê de Ética em Pesquisa da PUCPR

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Plataforma Brasil

Continuação do Parecer: 2.824.728

Considerações Finais a critério do CEP:

Este parecer foi elaborado baseado nos documentos abaixo relacionados:

Tipo Documento	Arquivo	Postagem	Autor	Situação
Informações Básicas do Projeto	PB_INFORMAÇÕES_BÁSICAS_DO_PROJETO_1048062.pdf	18/07/2018 09:30:09		Aceito
Projeto Detalhado / Brochura Investigador	Projeto_Plataforma_Brasil.pdf	18/07/2018 09:17:05	Brenda Sanchez Leyton	Aceito
Declaração de Manuseio Material Biológico / Biorepositório / Biobanco	Termo_de_transferencia_de_material_biologico.pdf	16/07/2018 13:50:40	Brenda Sanchez Leyton	Aceito
Folha de Rosto	FR.pdf	15/07/2018 17:00:56	Daniela Hyczy Floriani	Aceito

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

CURITIBA, 16 de Agosto de 2018

Assinado por:
NAIM AKEL FILHO
(Coordenador)

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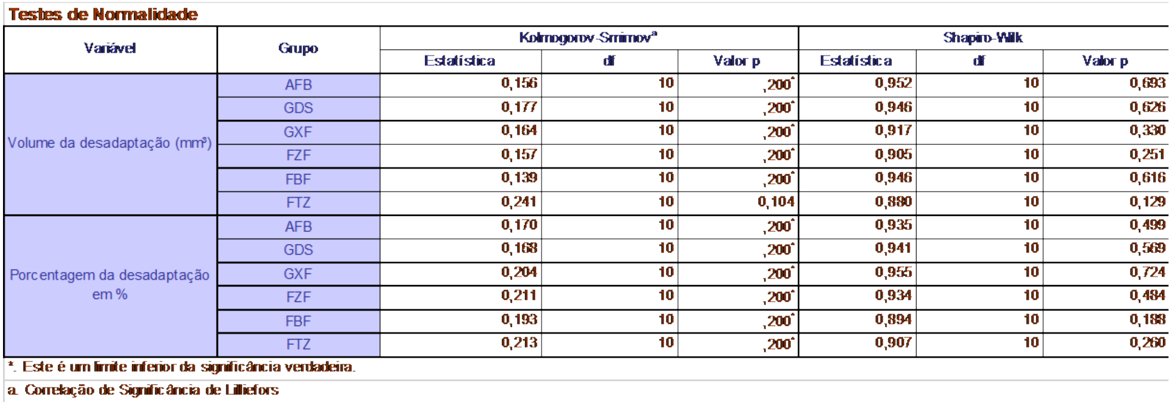
Página 04 de 04

Análise estatística

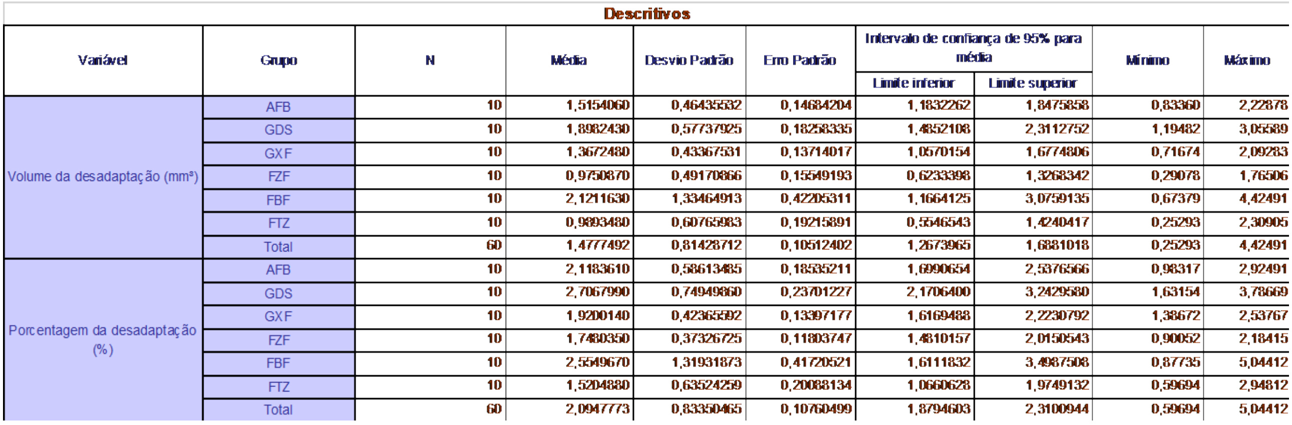


Testes de Normalidade

Variável	Grupo	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Estatística	df	Valor p	Estatística	df	Valor p
Volume da desadaptação (mm^3)	AFB	0,156	10	,200*	0,952	10	0,693
	GDS	0,177	10	,200*	0,946	10	0,626
	GXF	0,164	10	,200*	0,917	10	0,330
	FZF	0,157	10	,200*	0,905	10	0,251
	FBF	0,139	10	,200*	0,946	10	0,616
	FTZ	0,241	10	0,104	0,880	10	0,129
Porcentagem da desadaptação em %	AFB	0,170	10	,200*	0,935	10	0,499
	GDS	0,168	10	,200*	0,941	10	0,569
	GXF	0,204	10	,200*	0,955	10	0,724
	FZF	0,211	10	,200*	0,934	10	0,484
	FBF	0,193	10	,200*	0,894	10	0,188
	FTZ	0,213	10	,200*	0,907	10	0,260

*. Este é um limite inferior da significância verdadeira.

a. Correlação de Significância de Lilliefors



Descritivos

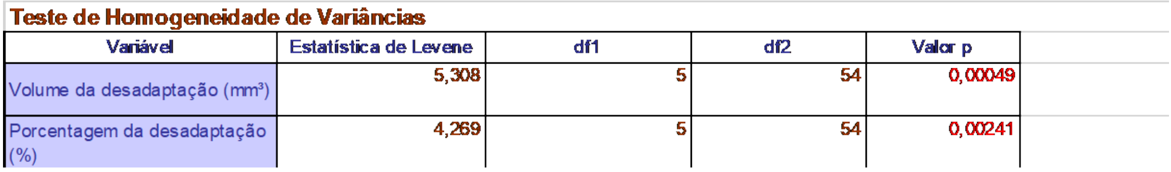
Variável	Grupo	N	Média	Desvio Padrão	Erro Padrão	Intervalo de confiança de 95% para média		Mínimo	Máximo
						Limite inferior	Limite superior		
Volume da desadaptação (mm^3)	AFB	10	1,5154060	0,46435532	0,14684204	1,1832262	1,8475858	0,83360	2,22878
	GDS	10	1,8982430	0,57737925	0,18258335	1,4852108	2,3112752	1,19482	3,05589
	GXF	10	1,3672480	0,43367531	0,13714017	1,0570154	1,6774806	0,71674	2,09283
	FZF	10	0,9750870	0,49170866	0,15549193	0,6233398	1,3268342	0,29078	1,76506
	FBF	10	2,1211630	1,33464913	0,42205311	1,1664125	3,0759135	0,67379	4,42491
	FTZ	10	0,9893480	0,60765983	0,19215891	0,5546543	1,4240417	0,25293	2,30905
	Total	60	1,4777492	0,81428712	0,10512402	1,2673965	1,6881018	0,25293	4,42491
Porcentagem da desadaptação (%)	AFB	10	2,1183610	0,58613485	0,18535211	1,6990654	2,5376566	0,98317	2,92491
	GDS	10	2,7067990	0,74949860	0,23701227	2,1706400	3,2429580	1,63154	3,78669
	GXF	10	1,9200140	0,42365592	0,13397177	1,6169488	2,2230792	1,38672	2,53767
	FZF	10	1,7480350	0,37326725	0,11803747	1,4810157	2,0150543	0,90052	2,18415
	FBF	10	2,5549670	1,31931873	0,41720521	1,6111832	3,4987508	0,87735	5,04412
	FTZ	10	1,5204880	0,63524259	0,20088134	1,0660628	1,9749132	0,59694	2,94812
	Total	60	2,0947773	0,83350465	0,10760499	1,8794603	2,3100944	0,59694	5,04412

Testes de efeitos entre sujeitos

Variável dependente: Volume da desadaptação (mm^3)

Fonte de Variação	Tipo III Soma dos Quadrados	gl	Quadrado Médio	F	Valor p	Poder observado[b]
Grupo	10,956	5	2,191	4,201	0,00268	0,94043
Erro	28,164	54	0,522			
Total corrigido	39,121	59				

b. Calculado usando alfa = ,05



Teste de Homogeneidade de Variâncias

Variável	Estatística de Levene	df1	df2	Valor p
Volume da desadaptação (mm^3)	5,308	5	54	0,00049
Porcentagem da desadaptação (%)	4,269	5	54	0,00241

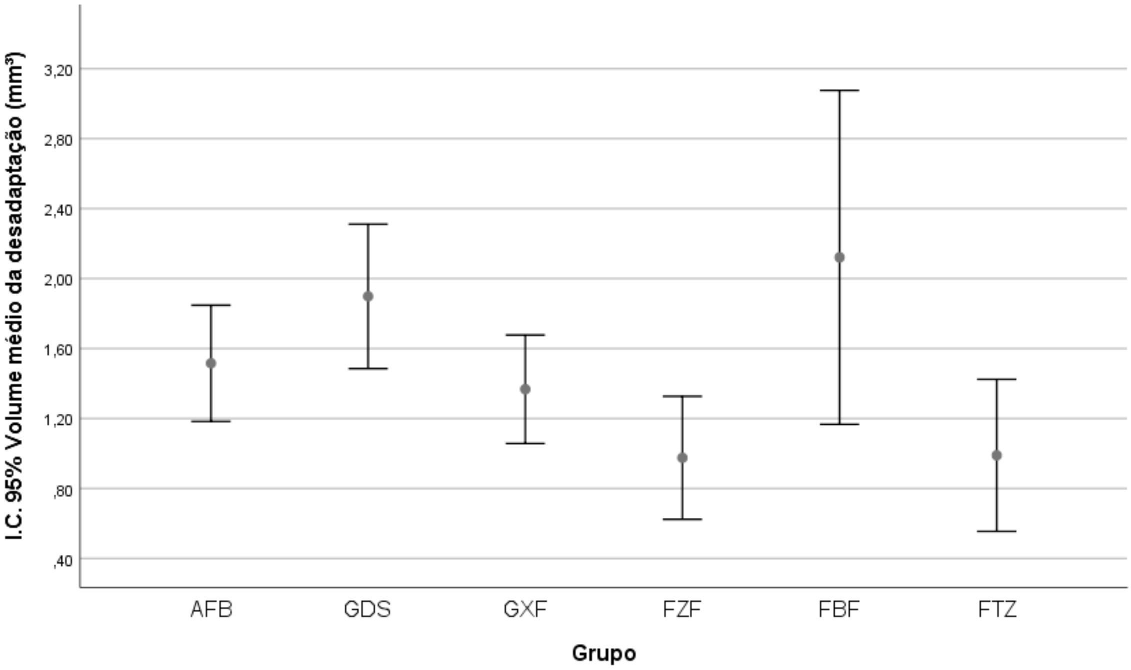
Comparações múltiplas

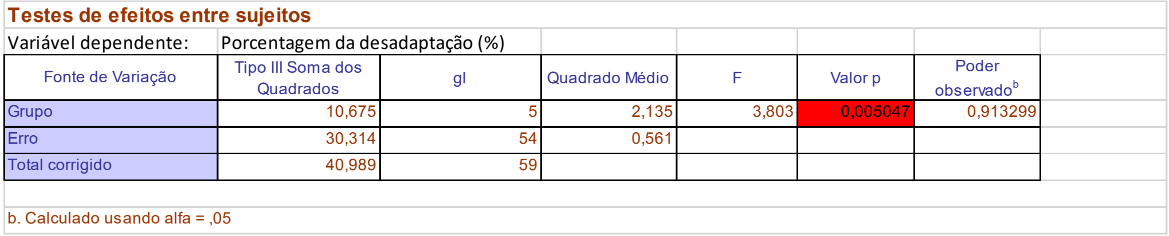
Variável dependente: Volume da desadaptação (mm³)

Games-Howell

(I) Grupo	(J) Grupo	Diferença média (I-J)	Erro Padrão	Valor p	Intervalo de Confiança 95%	
					Limite inferior	Limite superior
AFB	GDS	-0,3828370	0,23430592	0,5889	-1,1312533	0,3655793
	GXF	0,1481580	0,20092290	0,9744	-0,4907097	0,7870257
	FZF	0,5403190	0,21386988	0,1682	-0,1396117	1,2202497
	FBF	-0,6057570	0,44686846	0,7507	-2,1260618	0,9145478
	FTZ	0,5260580	0,24184216	0,2986	-0,2483918	1,3005078
GDS	AFB	0,3828370	0,23430592	0,5889	-0,3655793	1,1312533
	GXF	0,5309950	0,22835084	0,2380	-0,2009495	1,2629395
	FZF	,9231560*	0,23982164	0,0131	0,1588620	1,6874500
	FBF	-0,2229200	0,45985379	0,9959	-1,7621847	1,3163447
	FTZ	,9088950*	0,26506929	0,0303	0,0662535	1,7515365
GXF	AFB	-0,1481580	0,20092290	0,9744	-0,7870257	0,4907097
	GDS	-0,5309950	0,22835084	0,2380	-1,2629395	0,2009495
	FZF	0,3921610	0,20732865	0,4383	-0,2678706	1,0521926
	FBF	-0,7539150	0,44377501	0,5590	-2,2704097	0,7625797
	FTZ	0,3779000	0,23607726	0,6094	-0,3811555	1,1369555
FZF	AFB	-0,5403190	0,21386988	0,1682	-1,2202497	0,1396117
	GDS	-,9231560*	0,23982164	0,0131	-1,6874500	-0,1588620
	GXF	-0,3921610	0,20732865	0,4383	-1,0521926	0,2678706
	FBF	-1,1460760	0,44978503	0,1881	-2,6702354	0,3780834
	FTZ	-0,0142610	0,24718978	1,0000	-0,8036154	0,7750934
FBF	AFB	0,6057570	0,44686846	0,7507	-0,9145478	2,1260618
	GDS	0,2229200	0,45985379	0,9959	-1,3163447	1,7621847
	GXF	0,7539150	0,44377501	0,5590	-0,7625797	2,2704097
	FZF	1,1460760	0,44978503	0,1881	-0,3780834	2,6702354
	FTZ	1,1318150	0,46373902	0,2138	-0,4139617	2,6775917
FTZ	AFB	-0,5260580	0,24184216	0,2986	-1,3005078	0,2483918
	GDS	-,9088950*	0,26506929	0,0303	-1,7515365	-0,0662535
	GXF	-0,3779000	0,23607726	0,6094	-1,1369555	0,3811555
	FZF	0,0142610	0,24718978	1,0000	-0,7750934	0,8036154
	FBF	-1,1318150	0,46373902	0,2138	-2,6775917	0,4139617

*. A diferença média é significativa no nível ,05.





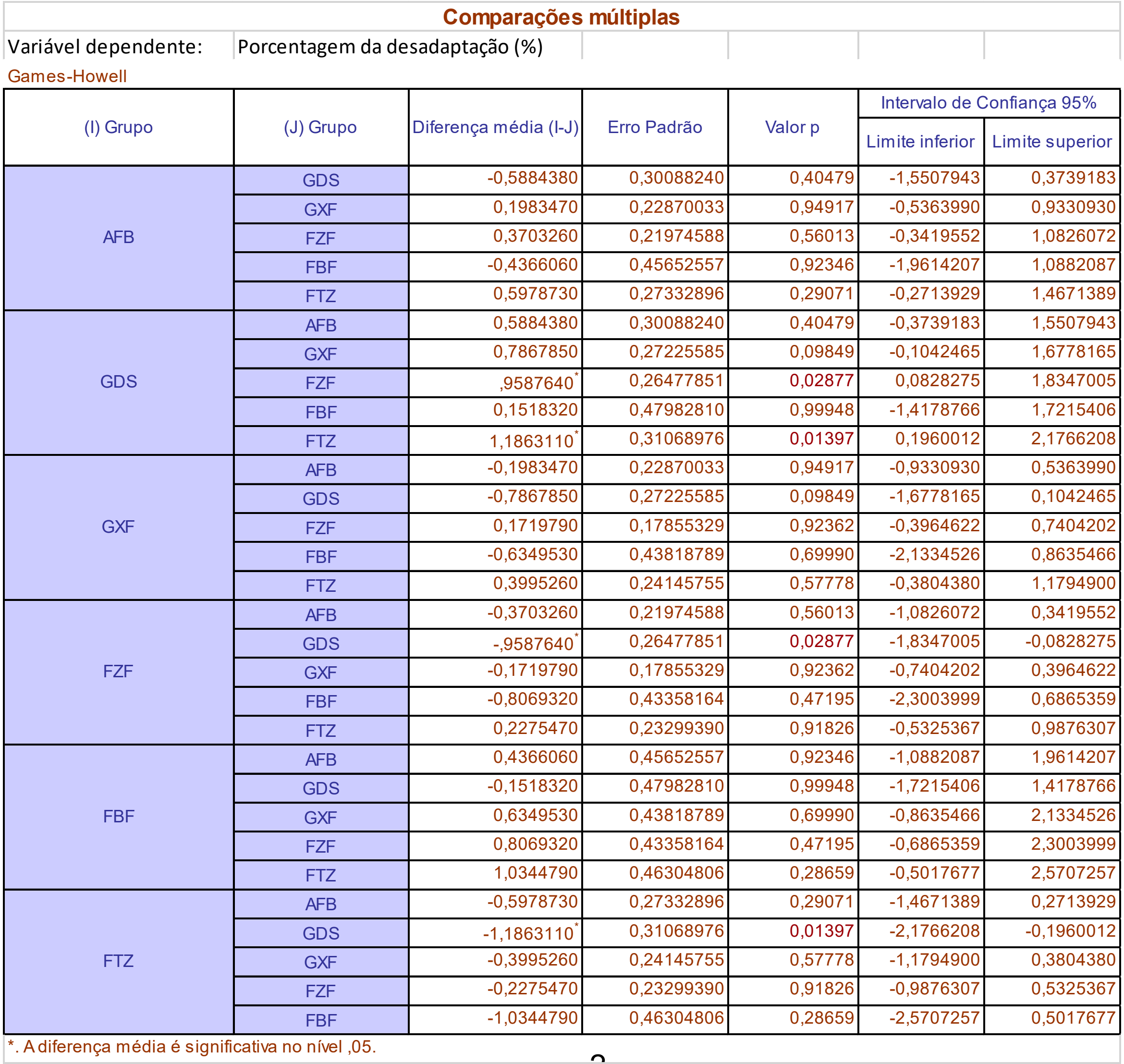
Testes de efeitos entre sujeitos

Variável dependente: Porcentagem da desadaptação (%)

Fonte de Variação	Tipo III Soma dos Quadrados	gl	Quadrado Médio	F	Valor p	Poder observado[b]
Grupo	10,675	5	2,135	3,803	0,005047	0,913299
Erro	30,314	54	0,561			
Total corrigido	40,989	59				

b. Calculado usando alfa = ,05

1



Comparações múltiplas

Variável dependente: Porcentagem da desadaptação (%)

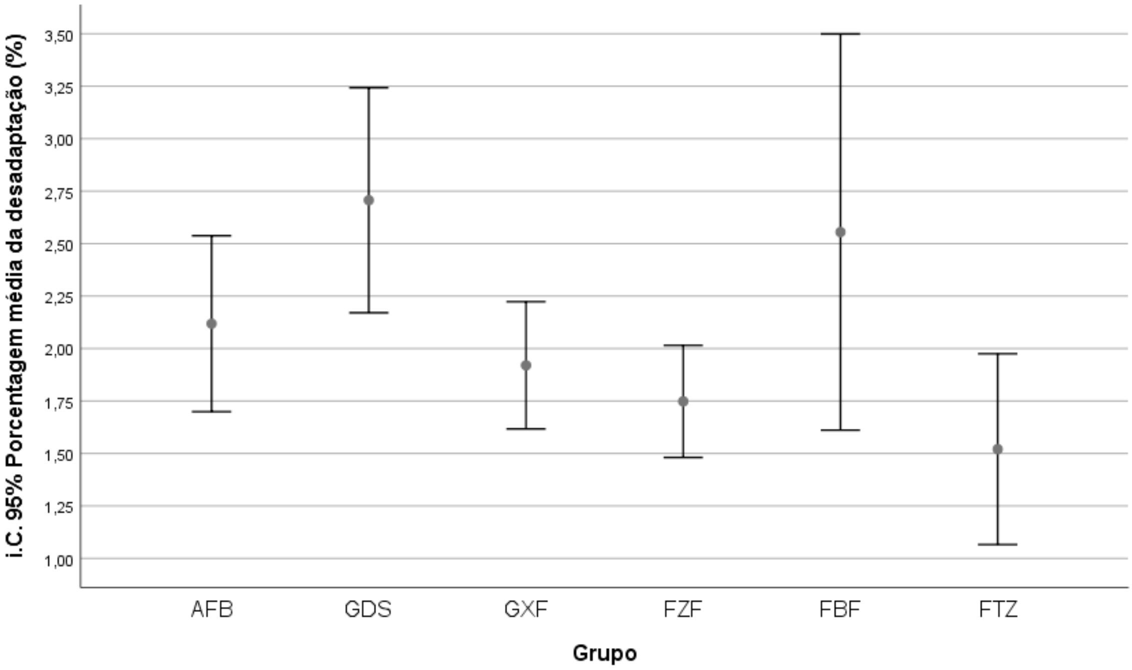
Games-Howell

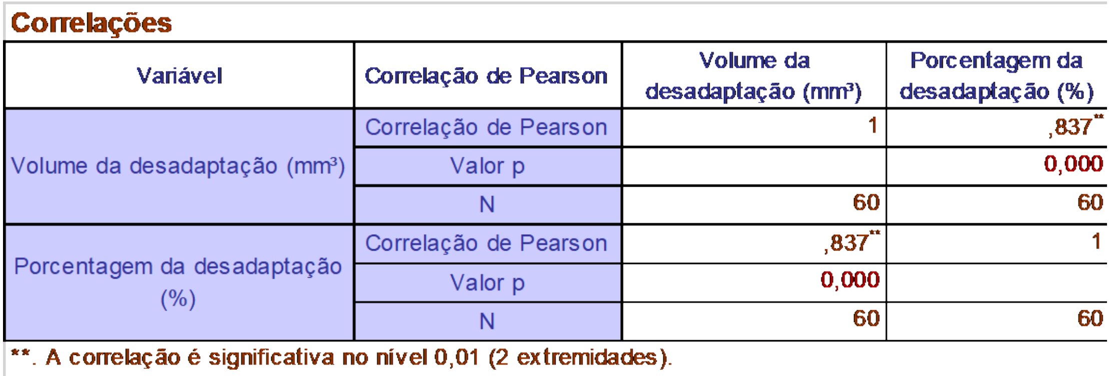
(I) Grupo	(J) Grupo	Diferença média (I-J)	Erro Padrão	Valor p	Intervalo de Confiança 95%	
					Limite inferior	Limite superior
AFB	GDS	-0,5884380	0,30088240	0,40479	-1,5507943	0,3739183
	GXF	0,1983470	0,22870033	0,94917	-0,5363990	0,9330930
	FZF	0,3703260	0,21974588	0,56013	-0,3419552	1,0826072
	FBF	-0,4366060	0,45652557	0,92346	-1,9614207	1,0882087
	FTZ	0,5978730	0,27332896	0,29071	-0,2713929	1,4671389
GDS	AFB	0,5884380	0,30088240	0,40479	-0,3739183	1,5507943
	GXF	0,7867850	0,27225585	0,09849	-0,1042465	1,6778165
	FZF	,9587640*	0,26477851	0,02877	0,0828275	1,8347005
	FBF	0,1518320	0,47982810	0,99948	-1,4178766	1,7215406
	FTZ	1,1863110*	0,31068976	0,01397	0,1960012	2,1766208
GXF	AFB	-0,1983470	0,22870033	0,94917	-0,9330930	0,5363990
	GDS	-0,7867850	0,27225585	0,09849	-1,6778165	0,1042465
	FZF	0,1719790	0,17855329	0,92362	-0,3964622	0,7404202
	FBF	-0,6349530	0,43818789	0,69990	-2,1334526	0,8635466
	FTZ	0,3995260	0,24145755	0,57778	-0,3804380	1,1794900
FZF	AFB	-0,3703260	0,21974588	0,56013	-1,0826072	0,3419552
	GDS	-,9587640*	0,26477851	0,02877	-1,8347005	-0,0828275
	GXF	-0,1719790	0,17855329	0,92362	-0,7404202	0,3964622
	FBF	-0,8069320	0,43358164	0,47195	-2,3003999	0,6865359
	FTZ	0,2275470	0,23299390	0,91826	-0,5325367	0,9876307
FBF	AFB	0,4366060	0,45652557	0,92346	-1,0882087	1,9614207
	GDS	-0,1518320	0,47982810	0,99948	-1,7215406	1,4178766
	GXF	0,6349530	0,43818789	0,69990	-0,8635466	2,1334526
	FZF	0,8069320	0,43358164	0,47195	-0,6865359	2,3003999
	FTZ	1,0344790	0,46304806	0,28659	-0,5017677	2,5707257
FTZ	AFB	-0,5978730	0,27332896	0,29071	-1,4671389	0,2713929
	GDS	-1,1863110*	0,31068976	0,01397	-2,1766208	-0,1960012
	GXF	-0,3995260	0,24145755	0,57778	-1,1794900	0,3804380
	FZF	-0,2275470	0,23299390	0,91826	-0,9876307	0,5325367
	FBF	-1,0344790	0,46304806	0,28659	-2,5707257	0,5017677

*. A diferença média é significativa no nível ,05.

2

3

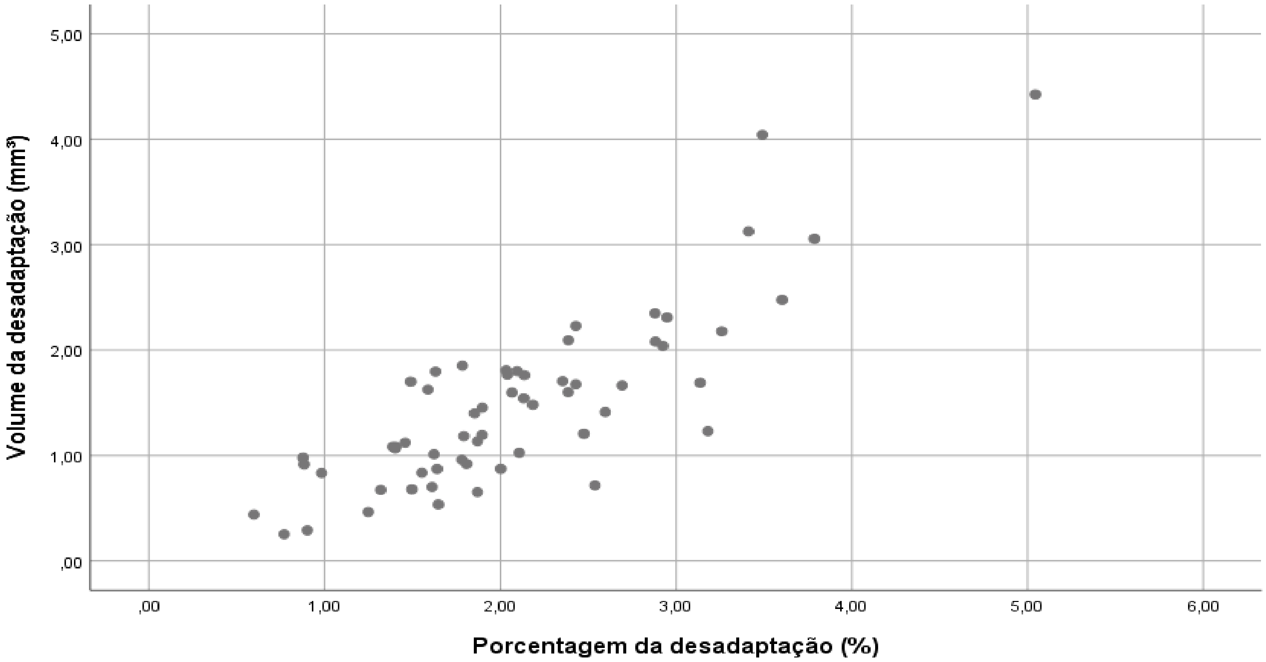




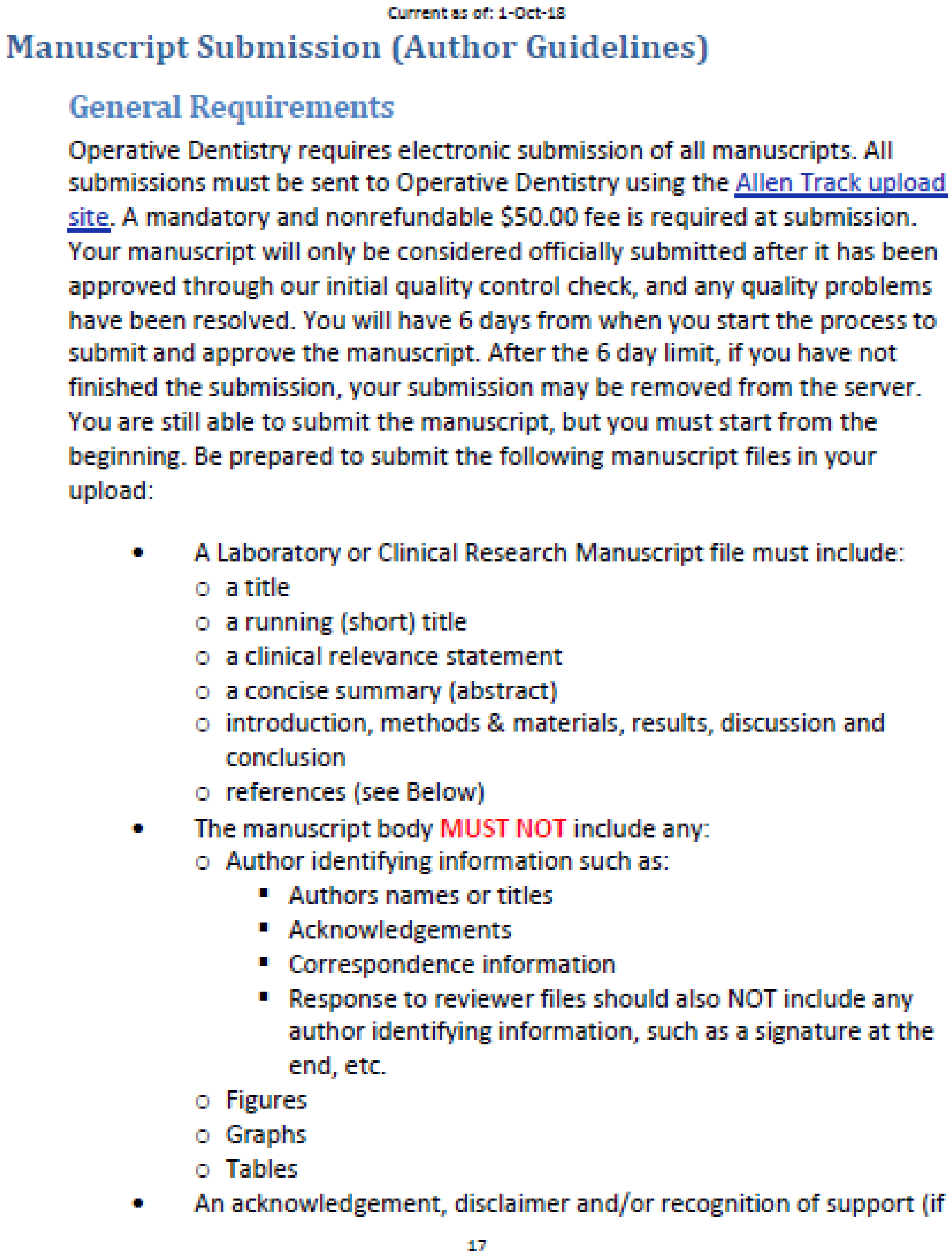
Correlações

Variável	Correlação de Pearson	Volume da desadaptação (mm^3)	Porcentagem da desadaptação (%)
Volume da desadaptação (mm^3)	Correlação de Pearson	1	,837**
	Valor p		0,000
	N	60	60
Porcentagem da desadaptação (%)	Correlação de Pearson	,837**	1
	Valor p	0,000	
	N	60	60

**. A correlação é significativa no nível 0,01 (2 extremidades).


Volume da desadaptação (mm³)
5,00
4,00
3,00
2,00
1,00
,00
,00
1,00
2,00
3,00
4,00
5,00
6,00
Porcentagem da desadaptação (%)

Normas da revista – Operative Dentistry



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    - a clinical relevance statement
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    - references (see Below)
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    - Author identifying information such as:
        - Authors names or titles
        - Acknowledgements
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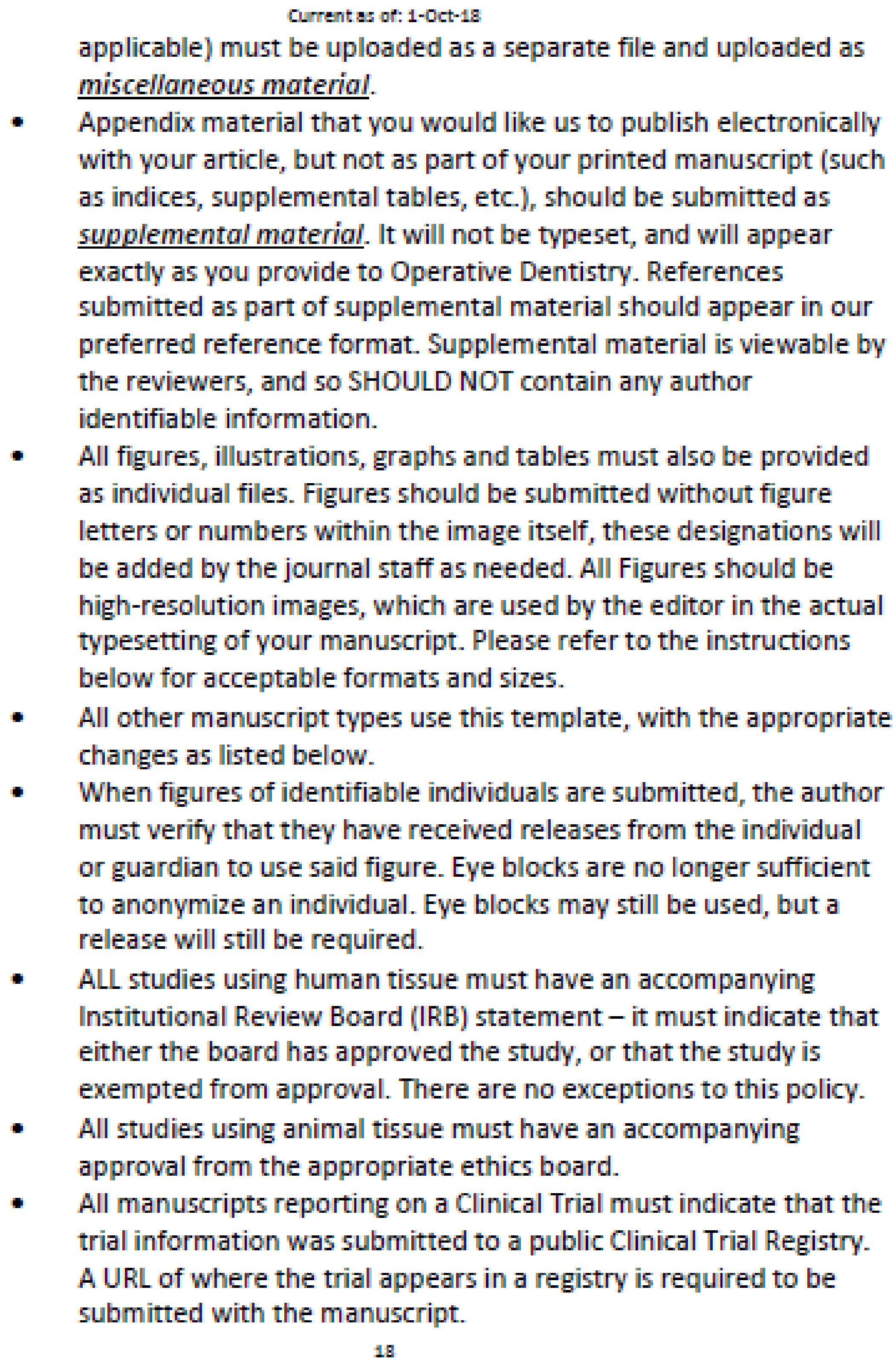
    - Figures
    - Graphs
    - Tables
- An acknowledgement, disclaimer and/or recognition of support (if



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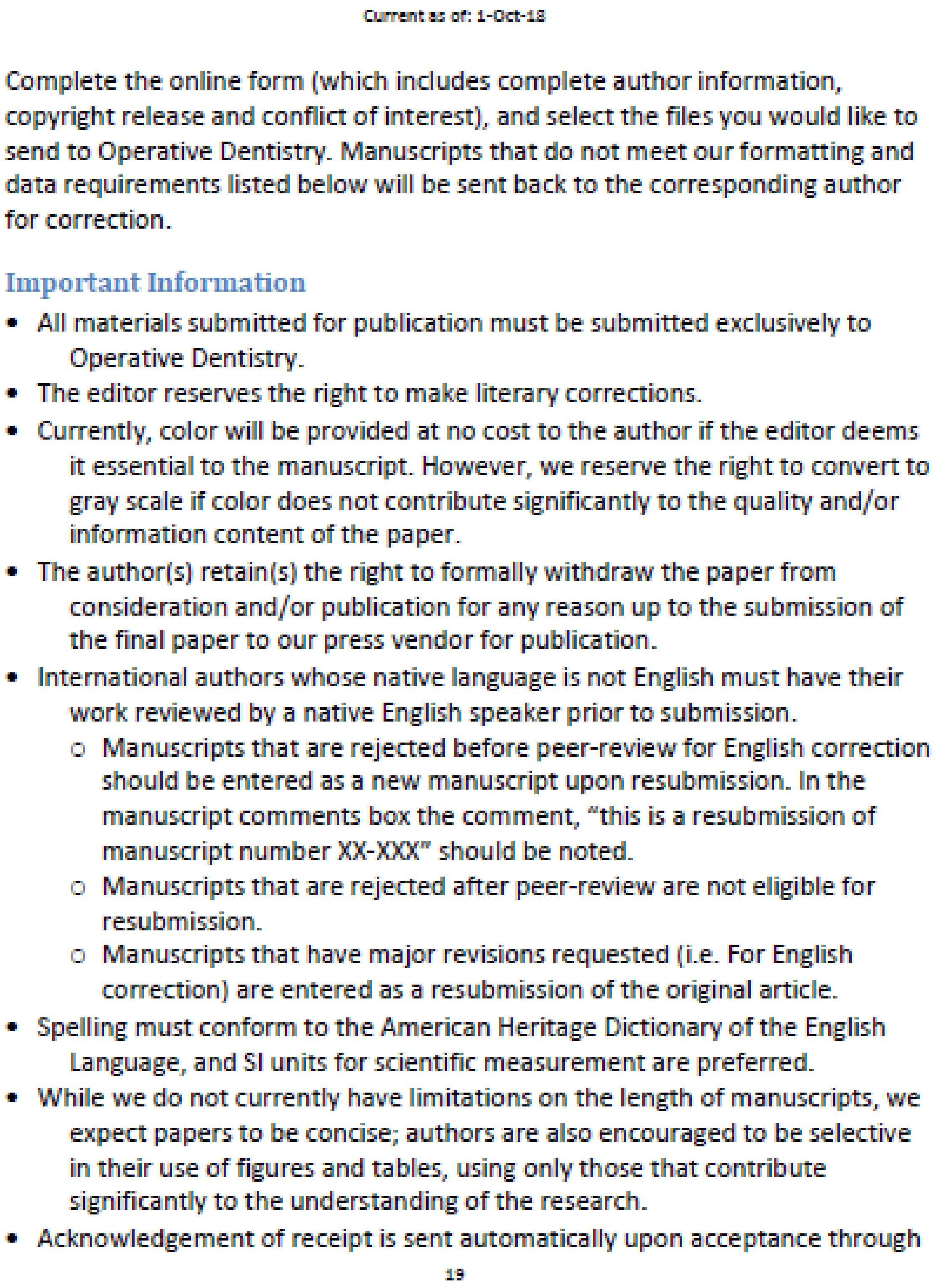

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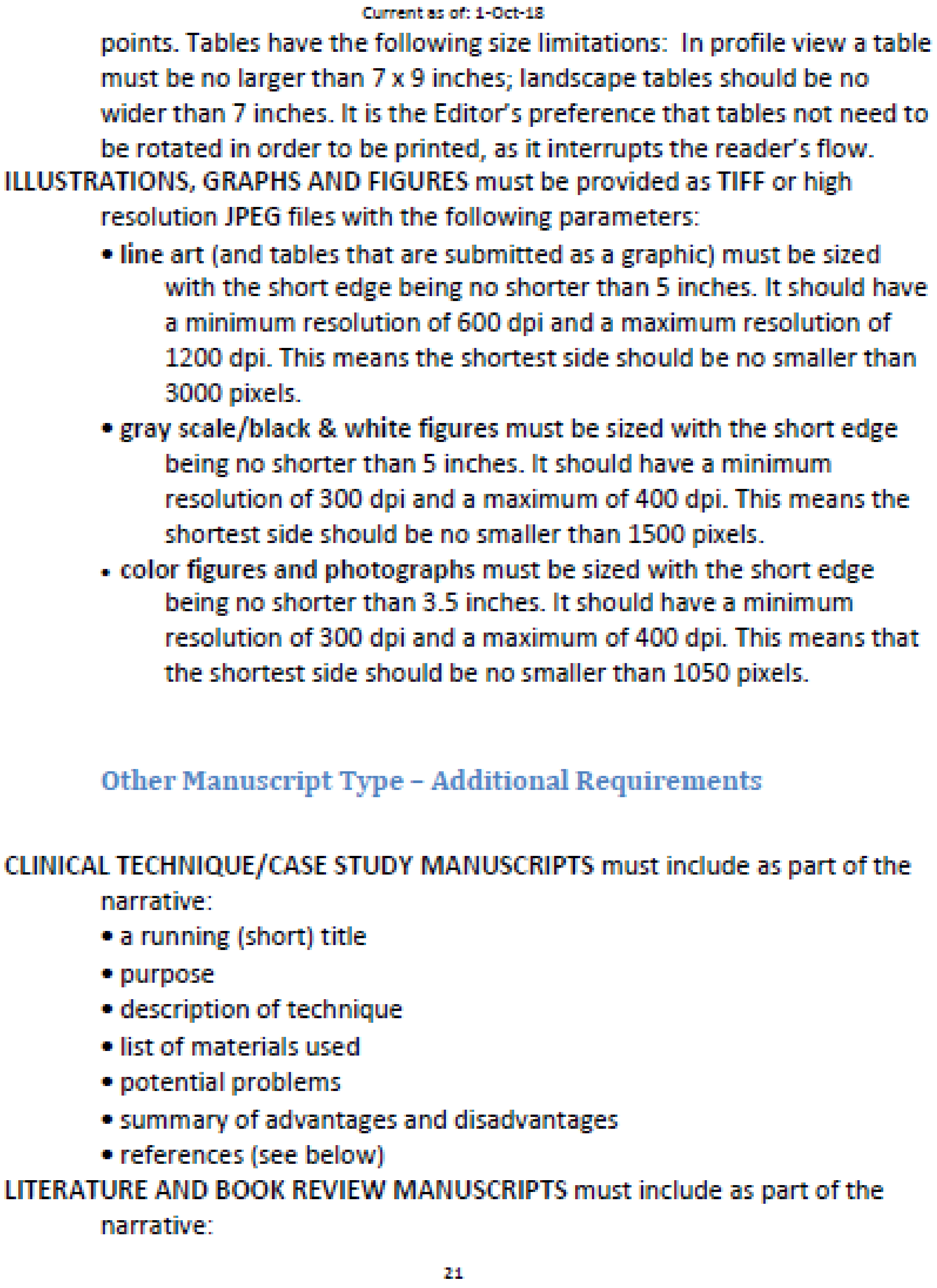

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ILLUSTRATIONS, GRAPHS AND FIGURES must be provided as TIFF or high resolution JPEG files with the following parameters:

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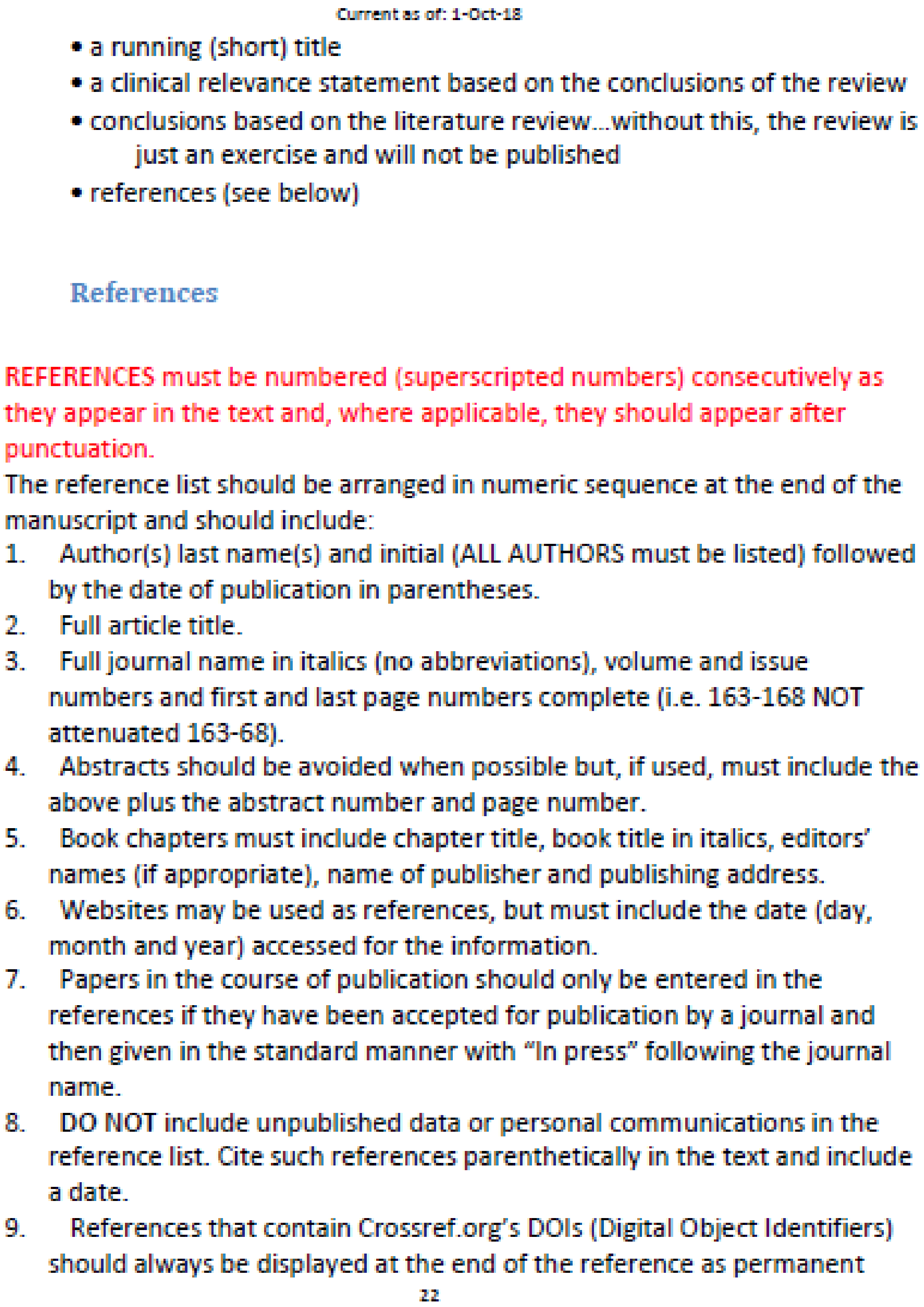
- purpose
- description of technique
- list of materials used
- potential problems
- summary of advantages and disadvantages
- references (see below)

LITERATURE AND BOOK REVIEW MANUSCRIPTS must include as part of the narrative:



- a running (short) title
- a clinical relevance statement based on the conclusions of the review
- conclusions based on the literature review…without this, the review is just an exercise and will not be published
- references (see below)

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3. Full journal name in italics (no abbreviations), volume and issue numbers and first and last page numbers complete (i.e. 163-168 NOT attenuated 163-68).
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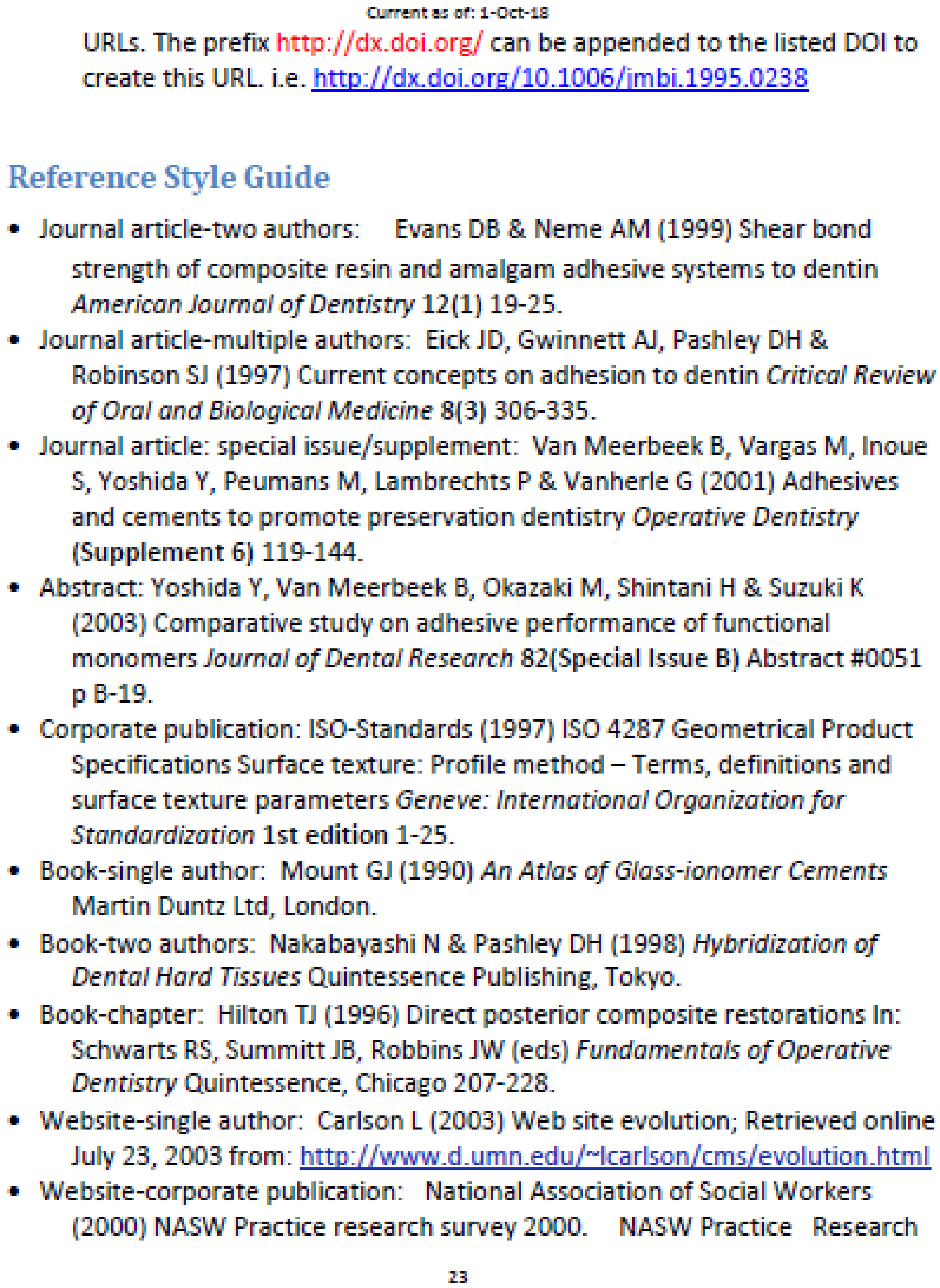

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