UNIVERSIDADE DE SÃO PAULO
FACULDADE DE ODONTOLOGIA DE BAURU

CAMILA THAIS QUEIROZ

Integrity of CAD/CAM onlays in ceramic and resin composite, associated or not with filler core – in vitro study

Integridade de restaurações CAD/CAM de cerâmica e resina composta tipo onlay, associadas ou não ao núcleo de preenchimento – Estudo in vitro

BAURU
2020

CAMILA THAIS QUEIROZ

Integrity of CAD/CAM onlays in ceramic and resin composite, associated or not with filler core – in vitro study

Integridade de restaurações CAD/CAM de cerâmica e resina composta tipo onlay, associadas ou não ao núcleo de preenchimento – Estudo in vitro

Dissertação apresentada a Faculdade de Odontologia de Bauru da Universidade de São Paulo para obtenção do título de Mestre em Ciências no Programa de Ciências Odontológicas Aplicadas, na área de concentração Dentística.

Orientador: Prof. Dr. Sérgio Kiyoshi Ishikiriama

BAURU

2020

Queiroz, Camila Thais
Integrity of CAD/CAM onlays in ceramic and resin composite, associated or not with filler core – in vitro study / Camila Thais Queiroz – Bauru 2020.

61p, il, 31cm.

Dissertação (Mestrado) – Faculdade de Odontologia de Bauru. Universidade de São Paulo

Orientador: Prof. Dr. Sérgio Kiyoshi Ishikiriama

Comitê de Ética da FOB-USP
Protocolo: 18008718.8.0000.5417
Data: 16/07/2019

FOLHA DE APROVAÇÃO

DEDICATÓRIA

Dedico este trabalho à minha família, em especial aos meus pais, Nelson e Glaura que nunca mediram esforços para me ajudar a concretizar meus sonhos e continuam me apoiando e ajudando a enfrentar cada obstáculo para realizar minhas metas de vida.

AGRADECIMENTOS GERAIS

A **Deus e Nossa Senhora Aparecida,** por me guiar e renovar minha fé todos os dias.

A **minha família**, meus irmãos (Bruno e Dhiego), cunhadas (Glaucia e Aline), sobrinha (Lívia) que sempre me incentivaram e torceram para que eu concluísse mais essa etapa.
Especialmente ao meu pai, **Nelson Queiroz** e minha mãe **Glaura Thais Luisi Queiroz** que não medem esforços para realizar as minhas metas. Vocês são meu exemplo de vida, desde quando decidi cursar odontologia tive o apoio de vocês, mesmo sabendo que não iria ser fácil. Pai, você é meu super herói, um exemplo, me sinto privilegiada por estudar e trabalharmos juntos. Mãe, você é minha preciosidade, a melhor que eu poderia ter. Vocês são a minha base. Amo vocês.

Aos meus amigos que a vida me deu, que sempre estiveram ao meu lado. Obrigada pelo companheirismo e momentos de distração.

Em especial a minha amiga **Helize Ane Cursino**, que sempre esteve do meu lado em todas as situações da minha vida, uma amizade que começou na graduação e permanece até hoje. Minha irmã, muito obrigada. Amo você.

Ao meu namorado **Carlos Rodrigo Fonseca Chieppe** que me apoia todos os dias, e deixa meus dias mais felizes. Também, obrigada pela sua paciência. Te Amo.

A minha turma de mestrado 2017, **Camila L., Alyssa, Daniela, Genine, Juliana, Francielly, Mariele, Leandro, Naoki e Victor**. Muito obrigada meus amigos, foi maravilhoso conhece-los e passar esses anos com vocês, obrigada pelo companheirismo e ensinamentos.

Aos colegas de pós graduação, que sempre me incentivaram e me ajudaram de alguma forma, desde meu egresso como aluna especial do mestrado.

Em especial quero agradecer **Fernanda Sandes Lucena, Camila Libardi e Leandro Edgar Pacheco** que se tornaram amigos desde o começo dessa jornada, posso dizer que são anjos, por que foram essenciais na minha formação. Obrigada pelos ensinamentos, companheirismo e risadas. Vou levar vocês pro resto da vida no meu coração. Amo vocês.

Ao meu colega **Edgar Massunari Maenosono** que foi meu parceiro e essencial no desenvolvimento da minha pesquisa. Muito Obrigada, você é especial.

Aos professores do Departamento de Dentística FOB-USP: **Prof. Dr. Rafael Mondelli, Prof. Dr. José Mondelli, Profa. Dra. Linda Wang, Dra. Juliana Fraga Soares Bombonati, Profa. Dra. Ana Flávia Sanches Borges Profa. Dra. Maria Teresa Atta, Prof. Dr. Aquira Ishikiriama, Prof. Dr. Adilson Yoshio Furuse, Profa. Dra. Diana Gabriela Soares, Prof. Dr. Paulo Afonso Silveira Francisconi e Profa. Dra. Maria Fidela de Lima Navarro** que contribuíram para a minha formação profissional e pessoal. Sou fã de vocês. Muito Obrigada.

Ao meu orientador **Prof. Dr. Sérgio Kiyoshi Ishikiriama**, que me acolheu e foi essencial pelo meu crescimento profissional e pessoal. Muito obrigada professor, pelo seu ensinamento, incentivo, conselhos e paciência.

Aos funcionários do Departamento de Dentística FOB-USP: **Nelson, Rita, Audria**, **Natália**, **Charlene**, **Alcides, Elísio** e **Zuleica,** que sempre com muita alegria, carinho e paciência me ajudaram em todos esses anos. Muito obrigada.

AGRADECIMENTOS INSTITUCIONAIS

À **Faculdade de Odontologia de Bauru - Universidade de São Paulo (FOB-USP)**, por todo conhecimento que me proporcionou durante o mestrado, foi a realização de um sonho poder estudar nessa instituição.

À **Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES**) - Código de Financiamento 001 que financiou parte deste estudo (#134118/2017-0).

Ao **Prof. Dr. Vahan Agopyan,** digníssimo reitor da Universidade de São Paulo.

Ao **Prof. Dr. Carlos Ferreira dos Santos**, diretor da FOB-USP e exemplo de dedicação e profissionalismo.

À **Prof. Dra. Profa. Izabel Regina Fischer Rubira de Bullen**, presidente da Comissão de Pós-graduação da FOB-USP.

ABSTRACT

Integrity of CAD/CAM onlays in ceramic and resin composite, associated or not with filler core – in vitro study.

This in vitro study evaluated the integrity of indirect onlay restorations made of leucite-reinforced ceramic (IPS Empress CAD, Ivoclar Vivadent, Schaan, Liechtenstein) and nanoceramic composite resin (LAVA Ultimate, 3M ESPE, São Paulo, Brasil), with and without resin composite filler core (Tetric Ceram, IvoclarVivadent and FiltekZ350 XT, 3M ESPE). Sixty extracted third molars were prepared by planning the occlusal surface with total removal of enamel, until a standard 3mm high crown were obtained. The preparation was performed involving only the distal half of the remaining crown, which was worn with total removal of 2 mm in height of the crown, remaining 1 mm of enamel in the cervical region to make the chamfered end. After standardized preparation, the specimens were divided into four groups: (n=15): Group 1: Leucite-reinforced ceramic onlays without filler core (LC); Group 2: nanoceramic resin composite onlays without filler core (NRC); Group 3: leucite-reinforced ceramic onlays with previous filler core (LC-F) and Group 4: nanoceramic resin composite onlays with previous filler core (NRC-F). In groups 3 and 4 specimens, the filler cores were made with composite resin and over the resin filler core, a standardize preparation was made. All prepared specimens were scanned by a intraoral digital scanner and the ceramic and nanoceramics resin blocks were milled in CAD / CAM to obtain partial crowns that were cemented with Variolink N dual resin cement, (Ivoclar Vivadent, Schaan, Liechtenstein) for ceramics and RelyX Ultimate (3M, ESPE) for nanoceramic resin composite. The specimens were stored in distilled water in an oven at 37 °C throughout the process and at least 24 hours before testing .After cementation, the margins of all restorations were polished and subsequently, all samples were subjected to thermomechanical stress cycling from 5 ° to 55 ° C, simultaneously with compression cycling at different load intensities (100, 200, 300, 400, 450N) in each level 20,000 cycles were performed, totaling 100,000 cycles. At the end of the thermomechanical cycling, the onlays integrity was measured by the presence of cracks and catastrophic fractures, measured by scores. The scores were submitted to statistical analysis Friedman

repeated measures test with significance level of α=0,05, where no significance were found for both variation factors (“material” and the presence of “filler core”), since the survival rate between the groups were similar.

Keywords: Onlay. Leucite. Nanoceramic resin composite. Filler core. CAD/CAM.

RESUMO

Integridade de restaurações CAD/CAM de cerâmica e resina composta tipo onlay, associadas ou não ao núcleo de preenchimento – Estudo in vitro.

Este estudo in vitro avaliou a integridade de restaurações indiretas onlay feitas de cerâmica reforçada com leucita (IPS Empress CAD, IvoclarVivadent) e resinas nanocerâmicas (LAVA Ultimate, 3M ESPE), com e sem núcleo de resina composta. (Tetric Ceram, IvoclarVivadent e Filtek Z350 XT, 3M ESPE). Sessenta terceiros molares extraídos foram preparados planificando a superfície oclusal com remoção total do esmalte, até obter uma coroa padrão de 3 mm de altura. O preparo foi realizado envolvendo apenas a metade distal da coroa, que foi desgastada com remoção total de 2 mm de altura da coroa, permanecendo 1 mm de esmalte na região cervical para confeccionar o término chanfrado. Após o preparo padronizado, as amostras foram divididas em quatro grupos: Grupo 1: restaurações cerâmicas reforçada com leucita sem núcleo de preenchimento (LC); Grupo 2: restaurações resina nanocerâmica sem núcleo de preenchimento (NRC); Grupo 3: restaurações cerâmicas reforçadas com leucita com núcleo de preenchimento prévio (LC-F) e Grupo 4: restaurações resina nanocerâmica com núcleo de preenchimento prévio (NRC-F). Nas amostras do grupo 3 e 4, os núcleos de preenchimento foram feitos com resina composta e, sobre o núcleo de preenchimento, foi feita uma preparação padronizada. Todas as amostras preparadas foram digitalizadas por um scanner digital intraoral e os blocos de resina nanocerâmica e cerâmica foram fresados em CAD / CAM para obter coroas parciais que foram cimentadas com cimento resina Variolink N duplo (Ivoclar Vivadent, Schaan, Liechtenstein) para cerâmica e RelyXUltimate (3M, ESPE, São Paulo, Brasil) para resinas compostas de laboratório. As amostras foram armazenadas em água destilada em um forno a 37 ° C durante todo o processo e pelo menos 24 horas antes do teste. Após a cimentação, as margens de todas as restaurações foram polidas e, posteriormente, todas as amostras foram submetidas a ciclos termomecânicos de 5 ° a 55 ° C, simultaneamente com ciclos de compressão em diferentes intensidades de carga (100, 200, 300, 400, 450N) em cada nível foram realizados 20.000 ciclos, totalizando 100.000. Ao final do ciclo termomecânico, a integridade dos onlays foi medida pela presença de trincas e fraturas catastróficas, medidas por escores. Os escores foram

submetidos à análise estatística do teste de medidas repetidas de Friedman, com nível de significância de α = 0,05, onde não foram encontradas significâncias para os fatores de variação (“material” e presença de “núcleo de preenchimento”), uma vez que a taxa de sobrevivência entre os grupos foi semelhante.

Palavras-chave: Onlay. Leucita. Resina composta nanocerâmica. Núcleo de preenchimento. CAD/CAM.

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF ABBREVIATIONS AND ACRONYMS

CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
CEJ	Cement Enamel Junction
Hz	Hertz
LC-F	Leucite with filler core
LC	Leucite without filler core
mm	Milimeter
N	Newton
NRC-F	Nanoceramic resin composite with filler core
NRC	Nanoceramic resin composite without filler core

TABLES OF CONTENTS

1 INTRODUCTION

1 INTRODUCTION

Onlay restorations are indicated for posterior teeth with large loss of coronary structure, usually involving more than one cusp or for teeth with extensive restorations that need replacement and can be made directly or indirectly with composite resin or some ceramic systems[1]. Among the direct-use materials available for restorative dentistry practice, composite resin can be considered the most versatile due to its aesthetic characteristics, ease of handling and adhesive properties. Currently there are also indirect composite resin systems that have conquered the dental market due to their technical ease, besides the additional polymerization methods, incorporation of inorganic particles, possibility of repair, reinforcement of remaining dental structure and conservative preparation[2].

In the early 1980s, with the primary objective of improving the physical-mechanical properties of the existing direct-use composite resins, they suggested first-generation indirect microparticulate resins (Dentacolor, Kulzer; Isosit N, Ivoclar; Visio-Gem, 3M ESPE), where through more efficient laboratory polymerization processes it was possible to improve some properties. This technological development has increased the possibilities of indicating this restorative material for anterior and posterior teeth with a high incidence of chewing efforts[3,4] .

The development and evolution of CAD / CAM technology has led to a revolution in the ways in which restorative materials are produced, broadening its clinical indications. Composite resins also started to be used in CAD / CAM systems when, from the Z100 composite came the MZ100 system, which was currently replaced by the 3M ESPE LAVA Ultimate[5], aiming at obtaining some advantages over ceramics, such as the reduction of the cost associated with a stronger resinous material. Thus, with all this technological evolution, nowadays indirect technique composite resins can be used as more conservative and functional options in onlays, and their current indications for posterior teeth restorations are practically no different from ceramics[6].

Still among the aesthetic restorative materials, ceramics can be considered a great alternative to reproduce the structures of natural teeth. Although generally

debatable, ceramics are still considered the material of choice when dealing with indirect restorations, and their routine use is increasingly frequent, despite the long history of these materials in dentistry.[7]

Among the numerous modifications that ceramic systems have undergone, the pursuit of improving mechanical properties without losing aesthetic and adhesive properties has always been a priority. Among the currently available reinforced ceramics, reinforced glass ceramics stand out, which combine an adequate flexural strength for use without metal, and maintain the adhesive property that allows more conservative biomechanical preparations to be performed.[8]

One of the most suitable materials for subsequent indirect restorations is leucite-reinforced ceramics. The IPS Empress system (Ivoclar Vivadent, Schaan, Liechtenstein) was developed at Zurich University, Zurich, Switzerland in 1983. But only in 1990 was it available for clinical use[7]. The IPS Empress system consists of a leucite-reinforced fused glass ceramic initially designed for full restorations, however, according to the manufacturer, it can currently be indicated for the manufacture of inlays, onlays, crowns and veneers.[9]

The growing demand for an aesthetic smile has stimulated the development of metal-free ceramics such as feldspar, formed by feldspar, quartz and kaolin, followed by other types such as lithium disilicate-reinforced pressure sensitive porcelain and infiltrated porcelain by glass, expanding the choice of ceramics for indirect restorations. These improvements in mechanical resistance were necessary, in addition to the aesthetic issue, because feldspar ceramics are known for their higher incidence of fractures in the body of the blocks, mainly associated with their low flexural strength.[4,8] However, it was these mechanical enhancements that allowed the ceramics to be machined and associated with CAD / CAM systems.

For clinical success, besides the indirect restorative material, many other factors are involved, especially the biomechanical preparation of the remnant.[10] This concern with the preparation of the dental element for indirect restoration has long been the object of numerous clinical and laboratory studies, especially when the adhesion process was incipient and retention depended mainly on mechanical retention, and available materials were less resistant and needed a uniform thickness

to decrease the incidence of stress concentration and body fractures. Thus, in extensively destroyed teeth, the restorative protocol for confection of indirect onlay restorations involved a previous reconstruction of the dental remnant, which later allowed to perform a biomechanical preparation that should respect two main principles: uniform thickness of the indirect restorative material and mechanical retention.

Despite the evolution of ceramics that resulted in improvement of its mechanical properties and the knowledge of adhesion today, the biomechanical preparation whose principle should be associated with the restorative material, seems not to have accompanied this evolution. Thus, the classic biomechanical preparation of extensively destroyed teeth with previous reconstruction (filler core) continues to be advocated, despite all this evolution of indirect restorative materials and bonding systems. Therefore, there is a need to investigate whether the composite resin filler core is still necessary for the integrity of indirect restorations.

Therefore, the objective of this study was to comparatively evaluate the integrity of indirect onlay restorations made of leucite-reinforced ceramic (IPS Empress CAD, IvoclarVivadent, Schaan, Liechtenstein) and resin nanoceramic (LAVA Ultimate, 3M ESPE), with and without composite resin filler core after thermomechnical cycling test.

5 FINAL CONSIDERATIONS

5 FINAL CONSIDERATIONS

Considering that the results obtained in this research are in accordance with the literature, more research must be carried out in relation to the tested materials and applied methods.

REFERENCES

REFERENCES

1. Raptis NV, Michalakis KX, Hirayama H. Optical behavior of current ceramic systems. Int J Periodontics Restorative Dent. 2006;26:31-41.

2. Ritter AV, Baratieri LN. Ceramic restorations for posterior teeth: guidelines for the clinician. J Esthet Dent. 1999;11:72-86.

3. Borges AF, Santos Jde S, Ramos CM, Ishikiriama SK, Shinohara MS. Effect of thermo-mechanical load cycling on silorane-based composite restorations. Dent Mater J. 2012;31:1054-9.

4. Gomes EA, Assunção WG, Rocha EP, Santos PH. Cerâmicas odontológicas: o estado atual. Cerâmica. 2008; 54:319-325.

5. Ruse ND, Sadoun MJ. Resin-composite blocks for dental CAD/CAM applications. J Dent Res. 2014;93:1232-4.

6. Hirata R, Klymus ME, Mota E, Masotti AS. Restaurações indiretas em resina composta laboratorial em dentes posteriores: passos de execução clínica/laboratorial e apresentação de um novo sistema. Rev. Abo Nac.2002;10:219-24

7. Garcia LFR, Consani S, Cruz PC, Pires de Souza FCP. Análise crítica do histórico e desenvolvimento das cerâmicas odontológicas. RGO. 2011;59:.67-73.

8. Kelly JR, Benetti P. Ceramic materials in dentistry: historical evolution and current practice. Aust Dent J. 2011;56:84-96.

9. El-Mowafy O, Brochu JF. Longevity and clinical performance of IPS-Empress ceramic restorations--a literature review. J Can Dent Assoc. 2002;68:233-7.

10. Mondelli, J. et al. Fundamentos de Dentística Operatória. 2.ed. São Paulo: Ed. Santos; 2017.

11. Lambert H, Durand JC, Jacquot B, Fages M. Dental biomaterials for chairside CAD/CAM: State of the art. J Adv. Prosthodont. 2017;9:486–495.

12. Li RW, Chow TW, Matinlinna JP. Ceramic dental biomaterials and CAD/CAM technology: state of the art. J Prosthodont Res. 2014;58:208–216.

13. Roggendorf MJ, Kunzi B, Ebert J, Roggendorf HC, Frakenberger R, Reich SV. Seven-year clinical performance of CEREC-2-all-ceramic CAD/CAM resotrations placed within deeply destroyed teeth. 2012;15:1413-1424.

14. Calamia JR. Etched porcelain facial veneers: a new treatment modality based on scientific and clinical evidence. NY J Dent. 1983;53:255-9.

15. Calamia, JR, Simonsen RJ. Effect of coupling agents on bond strength of etched porcelain. J. Dent. Res. 1984;63:162-362.

16. Kern M, Strub JR, Lü X-Y. Wear of composite resin veneering materials in a dual-axis chewing simulator. J Oral Rehabil 1999;26: 372–378.

17. Kelly JR. Clinically relevant approach to failure testing of all-ceramic restorations. J Prost Dent. 1999;81:652– 61.

18. Kogowa EM, Calderon PS, Lauris JRP, Araujo CRP, Conti PCR. Evaluation os maximal bite force in temporomandibular disorders patients. J Oral Rehab. 2006;33:559-65.

19. Takaki P, Vieira M, Bommarito S. Maximum bite force analysis in different age groups speech therapy department. Int Arch Otorhinolaryngol. 2014;18:272–276.

20.Schindler HJ, Stengel E, SpiessWE. Feedback control during mastication of solid textures – a clinical-experimental study. J Prosthet Dent. 1998;80:330-336.

21.Kohyama K, Hatakeyama E, Sasaki T, Azuma T, Karita K. Effect of sample thickness on bite force studied with a multiple-point sheet sensor. J Rehabil Oral.2004;31:327-334.

22. Borba M, Cesar PF, Griggs JA, Della Bona A. Step-stress analysis for predicting dental ceramic reliability. Dent Mat. 2013;29:913-18.

23. Gresnigt MMM, Cune MS, Jansen K, Van der Made SAM, Özcan M.Randomized clinical trial on indirect resin composite and ceramic laminate veneers: up to 10-year findings. J Dent. 2019;86:102-9.

24. Cetin AR, Unlu N. Clinical wear rate of direct and indirect posterior composite resin restorations. Int J Periodontics Restorative Dent. 2012;32:e87-94.

25. Hampe R, Theelke B, Lümkemann N, Eichberger M, StawarczykB. Fracture toughness analysis of ceramic and resin composite CAD/CAM material. Oper Dent. 2019;44:e190-201.

26. Anusavice KJ et al. Phillips' science of dental materials. 12.ed. Filadélfia: Ed Saunders Elsevier, 2013.

27. Beltramini I, Machado CM, Jalkh EBB, Hirata R, Piza MMT, Bonfante EA. Resistência à flexão biaxial de resinas nanocerâmica antes e após o envelhecimento. Resumos. 2016.

28. Shembish F, Tong H, Kaizer M, Janal MN, Thompson VP, Opdam NJ, Zhang Y. Fatigue resistance of CAD/CAM resin composite molar crowns. Dent Mat. 2016;32:499-509.

29. Awada A, Nathanson D. Mechanical properties of resin-ceramic CAD/CAM restorative materials. J Prost Dent. 2015;114:587-93.

30. Albero A, Pascual A, Camps I, Grau-Benitez M. Coparative characterization of a novel cad-cam polymer-inflitrated-ceramic-network. J Clin Exp Dent. 2015;7:e495-500.

31. Heintze SD, Cavalleri A, Forjanic M, Zellweger G, Rousson V. Wear of ceramic and antagonits – A systematic evaluation of influencing factors in vitro. Dent Mat. 2008; 24:433-49.

32. Mamoun J. Post and core build-ups in crown and bridge abutments: bio-mechanical advantages and disadvantages. J Adv Prosthodont. 2017;9:232-37.

33. Krejci I, Lutz F, Reimer M. Wear of CAD/CAM ceramic inlays: restorations, opposing cusps and luting cements. Quint Int. 1994;25:199-207.

APPENDIX

APPENDIX

APÊNCIDE A - DECLARAÇÃO DE USO EXCLUSIVO DE ARTIGO EM DISSERTAÇÃO/TESE

DECLARATION OF EXCLUSIVE USE OF THE ARTICLE IN DISSERTATION/THESIS

We hereby declare that we are aware of the article (Integrity of CAD/CAM onlays in ceramic and resin composite, associated or not with filler core – in vitro study) will be included in (Dissertation/Thesis) of the student (Camila Thais Queiroz) and may not be used in other works of Graduate Programs at the Bauru School of Dentistry, University of São Paulo.

Bauru, th, 2020.

Camila Thais Queiroz
Author

_____
Signature

Sérgio Kiyoshi Ishikiriama
Author

_____
Signature