Eduardo Tadashi Pinto Emi

# Avaliação clínica retrospectiva das complicações longitudinais de próteses implanto-suportadas confeccionadas pelos métodos convencional e CAD/CAM

Tese apresentada à Faculdade de Odontologia da Universidade Federal de Uberlândia, para obtenção do Título de Doutor em Odontologia na Área de Clínica Odontológica Integrada.

Uberlândia
2020

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*Retrospective clinical evaluation of peri-implant and prosthetic complications in conventional and Cad / Cam methods*

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Orientador: Prof. Dr. Paulo Cézar Simamoto Júnior

Banca Examinadora:
Prof. Dr. Paulo Cézar Simamoto Júnior
Prof. Dr. Guilherme José Pimentel Lopes de Oliveira
Prof. Dr. Flávio Domingues das Neves
Prof. Dr.Thiago Carneiro
Prof. Dr. Roberto Sales e Pessoa

Uberlândia
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**UNIVERSIDADE FEDERAL DE UBERLÂNDIA**
Coordenação do Programa de Pós-Graduação em Odontologia
Av. Pará, 1720, Bloco 4L, Anexo B, Sala 35 - Bairro Umuarama, Uberlândia-MG, CEP 38400-902
Telefone: (34) 3225-8115/8108 - www.ppgoufu.com - copod@umuarama.ufu.br

# ATA DE DEFESA - PÓS-GRADUAÇÃO

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Reuniu-se no Anfiteatro/Sala 31 Bloco 4L Anexo A, Campus Umuarama, da Universidade Federal de Uberlândia, a Banca Examinadora, designada pelo Colegiado do Programa de Pós-graduação em Odontologia, assim composta: Professores Doutores: Guilherme José Pimentel Lopes de Oliveira (UFU); Karla Zancopé (UFU); Roberto Sales e Pessoa (UNITRI); Thiago de Almeida Prado Naves Carneiro (UNITRI) ;Paulo Cézar Simamoto Júnior (UFU) orientador(a) do(a) candidato(a).

Iniciando os trabalhos o(a) presidente da mesa, Dr(a). Paulo Cézar Simamoto Júnior, apresentou a Comissão Examinadora e o candidato(a), agradeceu a presença do público, e concedeu ao Discente a palavra para a exposição do seu trabalho. A duração da apresentação do Discente e o tempo de arguição e resposta foram conforme as normas do Programa.

A seguir o senhor(a) presidente concedeu a palavra, pela ordem sucessivamente, aos(às) examinadores(as), que passaram a arguir o(a) candidato(a). Ultimada a arguição, que se desenvolveu dentro dos termos regimentais, a Banca, em sessão secreta, atribuiu o resultado final, considerando o(a) candidato(a):

[A]provado(o).

Esta defesa faz parte dos requisitos necessários à obtenção do título de Doutor.

O competente diploma será expedido após cumprimento dos demais requisitos, conforme as normas do Programa, a legislação pertinente e a regulamentação interna da UFU.

Nada mais havendo a tratar foram encerrados os trabalhos. Foi lavrada a presente ata que após lida e achada conforme foi assinada pela Banca Examinadora.

# DEDICATÓRIA

A Deus, o pai celestial soberano em todas decisões que nos confiou tamanha responsabilidade para exercermos de forma plena e digna nossa profissão e nosso papel na sociedade, trilhando o caminho da paz.

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# SUMÁRIO

## RESUMO

A implantodontia possibilitou diversas formas de reabilitações e supriu limitações no tratamento de pacientes edêntulos total ou parcial. O beneficio é notório para o paciente por permitir reestabelecer estética e função, sem atrapalhar a fala devolvendo eficiência mastigatória e a própria auto estima. Apesar da Implantodontia apresentar alto índice de aceitação e sucesso, o aumento da expectativa de vida e a popularização do tratamento requer pesquisas e estudos para que os tratamentos se tornem longevos e previsíveis. Neste sentido, a avaliação clínica longitudinal dos tratamentos se faz necessária para se indicar os aspectos relacionados ao sucesso e falha das reabilitações com implantes e próteses implanto-suportadas. No capitulo I foram avaliadas as complicações relacionadas à próteses parciais fixas posteriores implanto-suportadas em implantes hexágono externo, metaloceramicas confeccionadas sobre UCIA calcinável. Foram executadas análises clinicas avaliando as condições periimplantares (índice de placa visível, índice de sangramento gengival, largura da mucosa ceratinizada, profundidade de sondagem, sangramento à sondagem, nível de inserção); protéticas (ponto de contato, afrouxamento de parafuso, lasca ou fratura da cerâmica); radiográficas (perda óssea e desadaptação marginal); exame de potência de mordida e questionário de qualidade de vida. No capítulo II uma comparação entre próteses metaloceramicas em UCLA calcinável e próteses de zirconia confeccionadas em CAD/CAM foi realizada. Neste trabalho buscou-se demonstrar as possíveis diferenças clinicas, radiográficas e no índice de satisfação e qualidade de vida dos pacientes reabilitados com diferentes métodos de confecção das reabilitações implanto-suportadas.Já no capitulo III foram avaliadas reabilitações implanto-suportadas em diversas situações (implantes unitários, parciais e totais) todas executadas em CAD/CAM com próteses em zirconia monolítica ou estratificada. Todos pacientes foram submetidos à avaliações clinicas e radiográficas com o objetivo de identificar possíveis complicações periimplantares e protéticas. Concluiu-se que, os pacientes reabilitados com UCLA apresentaram taxa de sobrevivência satisfatória, porém quantidade de mucosite e periimplantite superior as próteses de zirconia confeccionadas em CAD/CAM. Os pacientes reabilitados

com próteses confeccionadas em Zirconia por sistema CAD/CAM também tiveram menos desaperto de parafuso, menos perda de ponto de contato, menor acumulo de placa e menos perda óssea ao longo do tempo. As próteses executadas em CAD/CAM apresentaram resultados satisfatórios com alta previsibilidade e baixos índices de complicação.

**PALAVRAS-CHAVE:** CAD/CAM, implantes dentais, UCLA, Zirconia, Complicações, periimplantar, protéticas.

## ABSTRACT

Implantology has made possible several forms of rehabilitation and has overcome limitations in the treatment of total or partial edentulous patients. The benefit is notorious for the patient because it allows to reestablish aesthetics and function, without disturbing speech, restoring masticatory efficiency and self-esteem. Despite the fact that Implantology has a high rate of acceptance and success, the increase in life expectancy and the popularization of treatment requires research and studies so that the treatments become long-lived and predictable. In this sense, the longitudinal clinical evaluation of the treatments is necessary to indicate the aspects related to the success and failure of the rehabilitation with implants and implant-supported prostheses. In chapter I, complications related to posterior fixed partial dentures implant-supported in external hexagon implants, metalloceramics made on calcinable UCIA were evaluated. Clinical analyzes were performed evaluating peri-implant conditions (visible plaque index, gingival bleeding index, keratinized mucosa width, probing depth, probing bleeding, insertion level); prosthetics (contact point, loosening of screw, splinter or fracture of the ceramic); radiographic (bone loss and marginal maladjustment); bite potency exam and quality of life questionnaire. In chapter II, a comparison between metalloceramic prostheses in calcinable UCLA and zirconia prostheses made in CAD / CAM was performed. In this work, we sought to demonstrate the possible clinical, radiographic differences and the satisfaction and quality of life of patients rehabilitated with different methods of making implant-supported rehabilitation. In chapter III, implant-supported rehabilitation was evaluated in several situations (single, partial and total implants) all performed in CAD / CAM with prostheses in monolithic or stratified zirconia. All patients underwent clinical and radiographic evaluations in order to identify possible peri-implant and prosthetic complications. It was concluded that patients rehabilitated with UCLA had a satisfactory survival rate, but the amount of mucositis and peri-implantitis was higher than the zirconia prostheses made in CAD / CAM. Patients rehabilitated with prostheses made in Zirconia by CAD / CAM system also had less loosening of screws, less loss of contact point, less plaque accumulation and

less bone loss over time. The prostheses performed in CAD / CAM showed satisfactory results with high predictability and low complication rates.

**KEY WORDS:** CAD/CAM, dental implants,failures.

# 1. INTRODUÇÃO E REFERENCIAL TEÓRICO

## Parte 1: Referente ao capitulo I

A reabilitação de pacientes edêntulos com implantes dentais osseointegráveis tem sido demonstrado como uma modalidade de tratamento altamente previsível (Berglundh et al., 2002).

O surgimento da Implantodontia trouxe várias possibilidades de tratamento reabilitador na Odontologia. Inicialmente, as próteses sobre implantes eram usadas em casos de edentulismo total. (ADELL, et al., 1981) Com o avanço dos estudos e a necessidade de reabilitações unitárias e parciais, houve o desenvolvimento de vários sistemas de implantes em relação à retenção dos pilares para melhor estabilidade dessas conexões em cada caso específico. (Michalakis, et al., 2003)

No universo da Implantodontia basicamente pode-se trabalhar com duas possibilidades: a prótese retida por parafuso, ou cimentada sobre um pilar aparafusado sobre o implante. A escolha de um ou outro tipo de prótese não está condicionada apenas à preferência do profissional; alguns fatores podem influenciar nesta escolha ou mesmo defini-la. As próteses cimentadas necessitam sempre da utilização de um intermediário protético, enquanto as próteses aparafusadas podem ser feitas sobre um intermediário ou diretamente sobre a plataforma do implante. (Misch, 2006) Entretanto, em todos os casos, o tipo de prótese a ser usado deve ser definido na fase do planejamento, antes da fase cirúrgica.

Uma das situações clínicas mais desafiadoras para a reabilitação de espaços edêntulos unitários e múltiplos encontra-se em regiões posteriores com espaço protético reduzido e distância interoclusal insuficiente, principalmente em casos nos quais os implantes foram colocados no supra ou ao nível da crista óssea. Nesses casos, o pilar do tipo UCLA foi indicado para a resolução protética, uma vez que esses pilares se conectam diretamente à plataforma do implante, diminuindo a altura necessária quando um intermediário protético é também utilizado. (Camargos et al., 2012; Montero et al., 2012).

Apesar do alto potencial de resolução de condições clínicas específicas, os pilares do tipo UCLA calcinável têm sido associados a

problemas como afrouxamento ou fratura do parafuso, perda óssea periimplantar e periimplantites (Vetromilla et al., 2018). Essas falhas foram relacionadas às distorções incorporadas ao componente quando submetido à fundição, além também da necessidade de altas temperaturas para o preparo da prótese durante a queima da cerâmica, o que induz o desajuste em pilares UCLA calcináveis (Neves et al., 2014; Ramos et al., 2014). Os implantes com pilar UCLA também apresentaram um índice mais alto de afrouxamento e fraturas do parafuso, uma vez que apenas o parafuso do pilar é responsável por manter a estabilidade da conexão na interface implante-pilar de implantes de conexão hexágono externos (Pessoa et al., 2010; Camargos et al., 2012; Kourtis et al., 2017). Além disso, o hexágono externo, que é o tipo de conexão mais utilizado associado ao pilar UCLA, apresentou maior perda óssea devido à transmissão desfavorável das forças oclusais ao osso periimplantar, em comparação com outros tipos de conexão implante-pilar, que podem predispor esse implante para apresentar algumas complicações biológicas como a ocorrência da saucerização e periimplantite (Cooper et al., 2016; Pessoa et al., 2017).

**Parte 2 : Referente aos capitulo II e III**

As restaurações livres de metal surgiram na Odontologia como uma opção de tratamento com ótimas características estéticas, desempenho biomecânico satisfatório e adaptação marginal aceitável, tanto em próteses sobre implantes como próteses sobre dentes. A partir do momento que houve uma grande demanda por esta modalidade de tratamento, viu-se a necessidade em melhorar as propriedades físicas, biomecânicas e estéticas das cerâmicas no intuito de introduzir seu uso de forma previsível na prática clinica diária e poder finalmente proporcionar a confecção de restaurações cerâmicas livres de metal, inclusive para casos parciais e totais ferulizados. (Bagegni, 2019)

As cerâmicas odontológicas podem ser classificadas em vítreas e policristalinas, que são separadas pela presença ou não de matriz vítrea

composta principalmente por uma cadeia básica de óxido de silício ($SiO_4$). (Della Bona, 2004) Dentre as cerâmicas vítreas, conhecidas por fornecerem excelente estética, pode-se destacar as feldspáticas, feldspáticas reforçadas por leucita e dissilicato de lítio, que são as cerâmicas vítreas mais utilizadas na Odontologia. (Gracis S, 2015) Apesar dos avanços dos materiais, a cerâmica ainda era um material frágil, e sua baixa resistência à fratura aliada à baixa resistência à flexão vinha à tona quando se discutia a possibilidade de confecção de próteses parciais fixas ferulizadas e pilares para próteses implantadas. (Sailer, 2007) Isto se tornava ainda mais crítico na região posterior da boca, onde as forças mastigatórias são maiores. A necessidade de melhores propriedades mecânicas em regiões sujeitas a maiores cargas mastigatórias levou à introdução de cerâmicas policristalinas, como a alumina e posteriormente a zircônia, na Odontologia.

Os avanços na tecnologia “Computer-Aided Design e Computer-Aided Manufacturing” (CAD / CAM) aceleraram o desenvolvimento de cerâmicas policristalinas de alta resistência, que praticamente não podem ser processadas pelos métodos laboratoriais tradicionais (Li, 2014). Os sistemas CAD/CAM presentes na odontologia contemporânea podem ser classificados em duas diferentes vertentes: Direto ou Indireto. (Kayatt F.E & Neves, 2013) O CAD Direto (de consultório), utiliza um scanner intra-oral, o que caracteriza a técnica como direta, que possibilita a obtenção de modelos digitais e desenvolvimento de trabalhos restauradores em um software, que atua após a captura da imagem pelo escâner. O CAD Indireto (de bancada) esta relacionado à otimização das técnicas e agilidade nas atividades laboratoriais, podendo acelerar muitos procedimentos como enceramento, inclusão, fundição e aplicação de porcelana (Neves, 2014). Após a digitalização de modelos de gesso, o que caracteriza a técnica como indireta, o desenho da restauração será o próximo passo. O CAD propriamente dito atua após a captura da imagem pelo escâner e trata-se de um software. Estes softwares, após a geração do modelo digital proveniente do escaneamento do modelo de gesso, são capazes de projetar copings para próteses cimentadas, pilares para implantes, estruturas para próteses aparafusadas, além de coroas unitárias, parciais e totais, demonstrando grande versatilidade para as várias situações

clínicas. Grande parte desses softwares, tanto para sistemas diretos como para os indiretos, permitem ainda que o operador possa personalizar o trabalho antes de enviá-lo ao sistema de fresagem ou CAM (Computer-Aided Manufacturing) propriamente dito. (Kayatt F.E & Neves, 2013)

Os CAD/CAM de laboratório possuem várias opções de materiais para confecção de coroas sobre dente e sobre implante. Um dos materiais mais utilizados recentemente pelos CAD/CAM de laboratório é a zircônia. Zircônia é um dióxido cristalino de zircônia ($ZrO_2$). Os cristais podem se organizar em 3 diferentes padrões: Monoclínica (M), Cúbica (C) e tetragonal (T). A fase tetragonal é a mais resistente e utilizada, entretanto é instável, ou seja, um jateamento ou alteração de temperatura podem fazer com que a zircônia altere sua fase tetragonal para a fase monoclínica (Manicone et al., 2007; Kelly e Denry et al., 2007).

Essa transformação pode gerar alterações estruturais dessa cerâmica e alterar as propriedades mecânicas. A fase monoclínica apresenta maior chances de presença de microtrincas e porosidade em sua estrutura e pode diminuir a previsibilidade do tratamento (Kelly e Denry et al., 2007). Na tentativa de estabilizar a fase tetragonal foi introduzido óxidos estabilizadores. A zircônia Y-TZP é estabilizada por óxido de ítrio ($y_2O_3$) e é a mais utilizada em reabilitações protéticas. A sua alta resistência permite a confecção de infra-estruturas como também como restaurações monolíticas. Para infra-estruturas é indicada para restaurações unitárias, parciais ou até mesmo totais. Na forma de restaurações monolíticas elas são pigmentadas para otimizarem a cor em regiões não estéticas, devido a sua cor branca leitosa, já nas regiões estéticas estas restaurações podem uma cerâmica de cobertura aplicada sobre a superfície.

Devido à aparência leitosa que comprometia a estética das primeiras gerações de zircônias, é habitual recobrir as estruturas com uma cerâmica vítrea em próteses que demandam uma melhor caracterização e mimetização. Entretanto, isso culminou no problema mais comum desse modelo de prótese, o lascamento da cerâmica de recobrimento, também conhecido como chipping, que tem sido apontado como o maior índice de complicações encontrado em

trabalhos clínicos executados em zirconia, ocorrendo mais frequentemente nestas próteses que nas metalocerâmicas. (Bomicke, 2016). Entretanto, pesquisas e aprimoramentos nas percepções estéticas das zircônias monolíticas estão cada vez mais frequentes, introduzindo novas possibilidades de cores e maquiagens, permitindo assim seu uso até em áreas estéticas, sem a necessidade de incrementos feldspáticos, diminuindo os riscos de fratura. (1 Heintze, 2010) Esta zircônia policromática pode ser maquiada com vários tons antes do processo de sinterização, e é utilizado por alguns sistemas CAD / CAM, como o Zirkonzahn (Zirkonzahn).

Acompanhamentos clínicos, demonstram uma grande indicação destas zircônias e demonstram uma alta incidência de lascamentos superficiais (Koenig et al. 2014) e de uma menor incidência de fraturas em regiões de pônticos em que os conectores se apresentaram com pouca espessura ou em áreas de cantileveres. Estes lascamentos estão mais associados à cerâmica de cobertura e foram correlacionados a presença de coroas na região antagonista, à presença de hábitos parafuncionais e do uso de placas oclusais noturnas (Koenig et al. 2014). Em reabilitações totais para evitar este lascamento, as incisais e superfícies oclusais estão sendo realizadas em zircônia monolítica (Rojas-Vizcaya, 2011, Pietro Venezia, 2015). Este procedimento tem sido proposto por outros autores com o objetivo de evitar fraturas catastróficas (Ohlmann et al. 2009, Pietro Venezia, 2015).

Além deste dados disponíveis na literatura, que direciona a redução de falhas relacionadas às reabilitações protéticas, entender o comportamento do antagonista em relação a uma restauração obtida com uma infra-estrutura em zircônia revestida por porcelana feldspática e também em oclusão com uma restauração em zircônia monolítica é um importante aspecto a ser avaliado. Alguns autores mostraram que as restaurações em zircônias monolítica causam um menor desgaste do antagonista do que as feldspáticas (Kim et al. 2012, Stober et al. 2014, Mundhe, 2015).

O Sistema Zirkonzhan é um dos vários sistemas de fresagem computadorizada disponíveis comercialmente para laboratório. O sistema faz a captação da imagem do preparo ou do implante diretamente de modelos de

gesso com auxílio de um escâner, que posteriormente é processada pela unidade CAD para que a restauração possa ser planejada auxiliada pelo computador e então materializada pela unidade fresadora CAM (Heyman et al, 1996). Várias restaurações podem ser planejadas em um curto período de tempo e em seguida serem todas materializadas em uma “bolacha” de zircônia. Assim, a tecnologia é capaz de promover várias restaurações cerâmicas em um dia de trabalho somente com uma única mão de obra especializada (Trost et al, 2006). A praticidade, rapidez, anatomia e adaptação das peças são as principais vantagens da utilização do CAD/CAM. Entretanto sabe-se que as restaurações metalo-cerâmicas convencionais sobre implantes e dentes fixadas com fosfato de zinco tem excelente longevidade (Näpänkangas & Raustia, 2008), e muitas vezes só são trocadas devido a estética insatisfatória, próximo a gengiva, ou cárie secundária depois de vários anos em função. Assim no momento do Estado da Arte, confronta-se a segurança da técnica convencional, que demanda um maior tempo de fabricação, com a rapidez de técnica inovadora e aparentemente promissora.

# Capítulo 1

**Original Research:** ***Analysis of the complications in implant supported fixed partial prothesis constructed with calcinable UCLA in the posterior region. A retrospective study with 4 to 10 years of follow-up.***

Eduardo Tadashi Pinto Emi, DDS, pHD[1] ; Thamires Diuquele da Silva, DDS, pHD [1]; Letícia Resende Davi, DDS, pHD [2]; Guilherme José Pimentel Lopes de Oliveira, DDS, pHD [2]; Paulo Cezar Simamoto Junior, DDS, pHD [2]; Roberto Sales e Pessoa, DDS, pHD [2,3]

**ABSTRACT**

***Purpose:*** The objective of this retrospective study was to clinically evaluate the success and complications of implant supported fixed partial prothesis with UCLA abutments supported on external hexagon connection implants in the posterior region of the oral cavity. ***Material and methods:*** This retrospective clinical study involved 25 patients with 91 external hexagon connection implants that supported 36 partial prosthesis with UCLA-type abutment. Clinical and radiographic analyzes were performed to evaluate the conditions of the prosthesis, the peri-implant tissues, and to measure the bone level around the implants. The implant survival rates and the possible risk indicators that were related with the occurrence of mechanical complications (Fractures of infrastructure; Fracture of veneering ceramics; Occlusal wear; Screw fracture; Screw loosening; Loss of contact point), and biological complications (mobility, pain, presence of peri-implantitis, radiographic distance from the implant platform to the top of the bone crest above 2mm) was also evaluated. ***Results:*** No implants were lost during the evaluation period which provided a 100% of survival rate after 4 to 10 years of follow-up. Regarding the complications observed in the rehabilitations, it was found that there were in general 56 implants that presented some type of biological complication while 43 implants presented some type of mechanical complication. Among the risk indicators that influenced the presence of complications, it was found that the presence of

biofilm, and the prosthesis antagonist being a natural tooth the relative risk statistically significantly for the occurrence of mechanical complications. Additionally, it was found that unfavorable occlusion and prosthesis antagonist being a natural tooth increased the relative risk for biological complications. ***Conclusion:*** It can be concluded that despite the relatively high rates of mechanical biological complications, the rehabilitation of posterior edentulous spaces with partial prothesis with external hexagon connection with UCLA abutment is predictable and presented high survival rates after 4 - 10 years of follow up.

**Keywords:** Bone Resorption, dental implant-abutment design, prosthesis failure

## INTRODUCTION

The use of osseointegrated implants has been revolutionized the philosophy of oral rehabilitation since it promotes the indication of more conservative rehabilitation techniques, which turns this therapy the first choice for aesthetics and functional oral rehabilitation in totally and partially edentulous patients[1]. Although the first systems contemplated the rehabilitation of fully edentulous patients with superior and inferior protocol-type prothesis[2, 3], currently all types of edentulism can be rehabilitated by means of prostheses supported by osseointegrated implants due to evolutions of the surgical techniques, macro and microstructures of the implants, prosthetic components and dental materials[1].

One of the most challenging clinical situations is the rehabilitation of single and partial edentulous spaces in the posterior region with diminished

prosthetic space, insufficient interoclusal distance in regions where the implants were placed at the supra or at the level of the bony crest. In these cases, the UCLA-type abutment has been indicated for the prosthetic resolution since these abutments connect directly to the implant platform, which may aid in the resolution of the aforementioned clinical problems[4, 5].

Despite the high potential for resolution of several prosthetic clinical conditions, UCLA-type abutments have been associated with problems such as screw loosening or fracture, peri-implant bone loss and peri-implantis(6). These failures were related with the need for high temperatures for the preparation of the prosthesis during the firing of ceramic, which induces the misadjustment in calcinable UCLA abutments[7, 8]. The implants with UCLA abutment also have been presented a higher index of screw loosening and fractures since only the abutment screw is responsible for maintaining the stability of the connection at the implant-abutment interface[5, 9, 10]. Furthermore, the external hexagon that is the type of connection more used associated with the UCLA abutment have been presented more bone loss due to the unfavorable transmission of the oclusal forces to periimplant bone, comparing to other implant-abutment connection types, which can predispose this implant to present some biological complications as the occurrence of the saucerization and the periimplantitis[11, 12].

Due to the high rates of the utilization of the UCLA-type abutments in the posterior region associated with the external hexagon connections, the continuous evaluation of the success and complications related with this of this type of rehabilitation is necessary. In this way, the aim of this study was to

evaluate the prevalence of the mechanical and biological complications and the risk indicators related with these events in implant-supported UCLA-type abutments with an external hexagon-type connection partial-crowns placed in the posterior region of the oral cavity.

## MATERIAL AND METHODS

### Study design

The conduction of this study was approved by the ethical committee for human research of our institution under the protocol CAAE 63911616.9.0000.5152. All patients who participated in this study read and signed the informed consent form. Twenty-five patients who presented partial splinted ceramic prosthesis supported by cylindrical implants with external hexagon connection type (TryOn, SIN Implant System, Sao Paulo, Brazil), and confectioned over calcinable UCLA abutments were included in this retrospective clinical study. It was performed clinical, radiographical, masticatory power, and quality of life analysis focusing on the prothesis and periimplant complications and their indicators risk factor. The survival and success rates of prosthetic rehabilitation and implants were also measured. The STROBE protocol for retrospective clinical studies was used as a guide to conduct this research. To participate in this research, patients should present at least one partial-prosthesis in the posterior region of the mouth supported by implants with external hexagon connection with the UCLA-type abutment, between 4-10 year after the prosthesis installation.

### Clinical analysis

The patients were analyzed in relation to the occurrence of complications related to mechanical (Fractures of infrastructure; Fracture of veneering ceramics; Occlusal wear; Screw fracture; Screw loosening; Loss of contact point), and biological parameters (mobility, pain, presence of peri-implantitis, radiographic distance from the implant platform to the top of the bone crest above 2mm). Then, the following parameters were noted and related as possible indicator risks for prosthetic and periimplant complications in 3 levels:

1) Characteristics of the implants (length, diameter and platform diameter);

2) Analysis of the peri-implant tissues: I) Biofilm index (BI): The biofilm adhered to the prostheses was evaluated as present or absent at the moment of the control, 0 for absence of plaque, 1-biofilm only detected with probing, 2- Visible biofilm; 3- Abundant biofilm; II) Gingival inflammation index (GI): Peri-implant inflammation index (PII). The degree of gingival inflammation around the implant was assessed as follow: 0- Absence of inflammation; 1- Mild inflammation and changes in the superficial coloring of the periimplant mucosa; 2- Moderate inflammation, redness, and bleeding under pressure; 3- Acute inflammation, redness, and tendency to spontaneous bleeding or ulceration; III) Keratinized mucosal index (KMI): The surfaces of the implants were evaluated to quantify the extent of the keratinized mucosa present around the implants, after slightly dry, the keratinized mucosal band was measured using a periodontal probe in millimeters; IV) Bleeding on probing (BOP)- It was defined as the bleeding the periimplant sulcus after the probing ; V) Probing Depth (PD): The PD (in mm) was measured in 4 surfaces of each implant (mesial, distal, buccal and lingual / palatal) and was defined as the distance from the

margin of the peri-implant mucosa to the bottom of the periimplant sulcus/ pocket;

3) Characteristics of the occlusion if it was favorable or unfavorable (Parafunctional habits, Infra occlusion, Premature contact).

**Radiographic Analysis**

Digital periapical radiographs were made in all patients to evaluate marginal adaptation and peri-implant bone level. To perform the radiographic examination, digital X-ray and positioners (Cone Indicator, Indusbello, Londrina, Paraná, Brazil) adapted to the digital sensor were used so that the X-ray beam was perpendicular to the surface of the implant.

**Statistical Analysis**

A descriptive statistical analysis was performed regarding the presence of mechanical and biological complications, implant characteristics, peri-implant tissue conditions, and occlusion conditions. Subsequently, the mechanical and biological complications were considered as the independent variables of this study and the effect of the following dependent variables: Implant characteristics, periimplant tissue conditions and occlusion conditions, on the occurrence of these complications were evaluated by the chi-square test. Thus, the relative risk for the assessment of risk indicators that influenced the presence of complications was determined. GraphPad Prism 6 software (San Diego, CA, USA) was used to perform the statistical analysis of this study and all tests were applied at a significance level of 5%.

**RESULTS**

Ninety-one implant that supported 36-fixed partial prostheses in the posterior region of the mouth were evaluated and were installed in 25 patients.

The mean of the follow-up was 86.43 ± 18.82 months, with a minimum follow-up of 48 months and a maximum of 120 months. All implants placed presented an external hexagon connection type that were rehabilitated with calcinable UCLA abutments, with splinted partial metalloceramic crowns, with screwed prostheses and retained by common screws, in the posterior region of the maxilla or mandible. No patient reported pain and no implant presented mobility at the time of reevaluation. No implants of prosthesis were lost during the evaluation period which provided a 100% of survival rate. The characteristics of the implants are described in the table 1.

Regarding the periimplant parameters, there was a high prevalence of biofilm occurrence (76 implants), inflammation of the periimplant margin (46 implants) and bleeding on probing (55 implants). Nevertheless, the periimplant clinical parameters in this population did not generally present large values for probing depth (1.88 ± 0.86 mm) and periimplant bone level (2.52 ± 1.16 mm) (Table 2). Regarding the prosthetic parameters, it was showed that majority of the implants had favorable occlusion (51 implants) and that most of the occlusal problems occurred due to the presence of parafunctional habits (14 implants) (Table 3).

Regarding the complications observed in the rehabilitations, it was found that there were in general 56 implants that presented some type of biological complication (peri-implantitis or periimplant bone level above 2 mm), while 43 implants presented some type of mechanical complication (loosening or screw fracture, absence of contact point, ceramic fracture, infrastructure fracture, and occlusion wear). It was found that 56 implants had bone level above 2mm and 35 of these implants had peri-implantitis (probing depth above

2mm associated with probing bleeding). The most prevalent mechanical complications were the absence of the contact point (23 prostheses) and screw loosening (14 prostheses) (Table 4).

Among the risk indicators that influenced the presence of complications, it was found that the presence of biofilm, the prosthesis antagonist being a natural tooth and the presence of peri-implantitis increased the relative risk statistically significantly for the occurrence of mechanical complications. Additionally, it was found that unfavorable occlusion and prosthesis antagonist being a natural tooth increased the relative risk for biological complications (Table 5).

**DISCUSSION**

This retrospective study was performed to evaluate mechanical and biological complications of calcinable UCLA prostheses in the posterior region of the mouth. The present results showed that UCLA allowed for predictable rehabilitation with high survival levels (100%), but with a relatively high level of complications (61.53%). Among the risk indicators evaluated as possible influencers for the occurrence of complications, it was found that the presence of biofilm and the presence of natural teeth as antagonists influenced the occurrence of mechanical complications, and that the presence of natural teeth as antagonists and unfavorable occlusion interfered with the occurrence of biological complications.

The biological complications were classified as the junction of cases of peri-implantitis or bone loss greater than 2 mm. These complications can have two origins according to late failures in the osseointegration process that

may occur due to the presence of peri-implantitis or occlusal trauma[13]. In the present study, it was showed that 8 implants presented peri-implantitis giving a prevalence of 8.79%. The assessment of the prevalence of peri-implantitis becomes difficult due to the use of different parameters as a cutoff point for the diagnosis of this disease[14, 15], due of it, the prevalence of peri-implantitis presented a high level of variation in different clinical studies (11-29%) [15-18]. Systematic literature reviews that applied statistical adjustments to find the most accurate peri-implantitis prevalence values found values between 9.25-12.8%[19, 20]. In the current study, the used diagnostic parameter of peri-implantitis was the classification of periodontal and peri-implant diseases that was determined by the American Academy of Periodontics and the European Federation of Periodontology in which it was determined that peri-implantitis is diagnosed when the bone level is higher than 3mm associated with probing depth above 6mm with bleeding on probing, in cases where there is no radiography at the time of implant placement[21]. Indeed, the prevalence rates of peri-implantitis showed in this study are consistent with what was commonly found in studies between 5 and 10 years of follow-up[14], which demonstrates that the use of the UCLA abutment does not promote increased prevalence of peri-implantitis.

Regarding another biological complication evaluated in this study, 61.53% of the implants presented bone level greater than 2mm. Relating this outcome with the prevalence of peri-implantitis data, it was showed that most of these complications were not accompanied by inflammatory processes induced by bacterial biofilm. Nevertheless, these bone losses may form niches that may initiate periimplant disease[22]. One possible reason for the high prevalence of

implants with bone level above 2mm found in this study may be related to the fact that the evaluated implant presented external hexagon connections present less efficient dissipation of occlusal forces than internal connections such as the Morse taper connections[10, 23, 24]. In fact, implants with Morse taper connections presented lower bone loss than the implants with external hexagon connections[12]. In addition, the use of a UCLA abutments has been associated with worse occlusal distributions than the double-screw abutments that improve biomechanical stability of the prostheses[25, 26].

Between the risk indicators evaluated, a statistically significant increase was observed for biological complications when patients had unfavorable occlusion or when the antagonist was a natural tooth. These findings demonstrate that, in the present study, the periimplant complications may be more related to the biomechanical factors, probably because the higher occlusal challenge in posterior region of the oral cavity, due to the higher occlusal forces in this region[27]. The high peri-implant strain concentrations, principally in external hexagon implants, may induce initial periimplant bone loss such as saucerization, which thereafter can predispose those implants to present some biological complications[11, 12]. In addition, it should be noted that one of the indications for UCLA-type abutment is precisely in areas of reduced interocclusal space that may occur due to coronary migration of natural teeth[4-6], which increases the possibility of rehabilitation in patients with occlusal maladjustment. which are related to premature contact and increased overload[28, 29].

Regarding mechanical complications, it was found that the absence of the contact point (25.27%) and the loosening of the screws (15.38%) were the most prevalent. The absence of contact point can occur due to the physiological movement of teeth that causes a maladjustment of contact points, especially in implant-supported rehabilitations where the neighboring elements are natural teeth[30, 31]. Thus, this phenomenon should be monitored to avoid food impaction that can induce bone resorption and patient discomfort, as well as to make closer proximal contacts to avoid future complications[31].

On the other hand, the screw loosening and fracture have been reported in previous studies as the most frequent prosthetic complication in screwed prostheses, ranging the prevalence from 8.9% to 21%[4, 5, 32]. The different screw loosening rates found in clinical studies are due to the fact that the stability of the implant / abutment connection may be influenced by a number of potential factor such as the geometrical interface of the components, the materials of the screws and prosthetic components, the torque application systems, the surface roughness of the components, the mechanical strength and passivity of the prosthetic components(33). A higher rate of screw loosening and fractures in external hexagon implants has been showed since only the abutment screw is responsible for maintaining the stability of the connection at the abutment-implant interface, unlike the internal connections[10, 34, 35]. Moreover, in calcinable UCLA-type abutments this problem is even greater because only one screw is responsible for fixation on the implant platform, which have greater implant-abutment mismatch due to the deformations induced by the abutment casting[4, 5, 7, 8].

Besides, this greater vertical mismatch between abutment and implant may promote bacterial accumulation and changes in the distribution of occlusal forces that may consequently lead to a higher periimplant bone loss[36, 37]. Larger marginal mismatches are found in calcinable UCLA abutments undergoing ceramic firing cycles, than in pre-machined abutments, which remain with the belt intact after the casting process[7]. Nevertheless, vertical maladaptations which could be assessed by radiography had a very low prevalence (5.49%), which demonstrates that vertical misfits are not entirely related to screw loosening as shown in a previous study[38]. The other mechanical complications evaluated in this study, such as ceramic fractures (2.19%); infrastructure fracture (1.09%) and occlusal wear (5.49%) had a low prevalence, and probably these events were related with the higher occlusal forces in the posterior region and the use of UCLA abutment have not influence in theses finds.

The relative risk assessment indicated that there is a higher incidence of mechanical complication, where there is the presence of bacterial biofilm or the antagonist is a natural tooth. The occurrence of major complications such as the loss of contact point and screw loosening should make it difficult for the patient remove the biofilm during the toothbrushing and probably this was the reason for the association of these events. In fact, it was showed that the repeated screw tightening that is associated with vertical mismatching induced more biofilm accumulation[39], and the tooth position (eg. tooth with absence of contact point) have huge effect on biofilm accumulation and composition[40]. In addition, the presence of teeth increases the occlusal loading magnitudes on

the prostheses, which may have interfered with the occurrence of biomechanical complications[27].

The findings of this study should be interpreted with caution due to the occurrence of some drawbacks as the limited sample size and retrospective design, and these limitates the inference of our findings. The unknowledge about the time in which the evaluated complications occurred in relation to the reference parameters evaluated as possible causes does not allow to determine the causality of the event. Thus, this study only has the possibility to assess risk indicators. True risk factors for mechanical and biological complications in implants rehabilitations associated with the use of UCLA abutments should be evaluated in longitudinal studies.

## CONCLUSION

It can be concluded that despite the relatively high rates of mechanical and biological complications, the rehabilitation of posterior edentulous spaces with external hexagon implants with UCLA abutment is predictable and presented high survival rates after 4 - 10 years of follow up. Indicator risk factors such as presence of antagonist being a natural tooth, unfavorable occlusion and presence of biofilm were related to the mechanical and biological complications.

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## Tables

**Table 1:** Implant characteristics

| Characteristcs | Type | Average ± sd / Frequence |
|---|---|---|

| | | |
|---|---|---|
| **Imptlant lengh** | 7 mm | 11 Implants |
| | 8.5 mm | 13 Implants |
| | 10 mm | 16 Implants |
| | 11 mm | 3 Implants |
| | 11.5 mm | 28 Implants |
| | 13 mm | 20 Implants |
| **Implant diameter** | 3.75 mm | 74 Implants |
| | 4.00 mm | 13 Implants |
| | 5.00 mm | 5 Implants |
| **Plataform diamater** | 4.10 mm | 86 Implants |
| | 5.00 mm | 5 Implants |

**Table 2:** Periimplant clinical parameters

| **Clinical Parameters** | **Score** | **Average ± sd / Frequence** |
|---|---|---|
| **Keratinized mucosa length** | | 2.46 ± 0.92 mm |
| **Keratinized mucosa thickness** | | 1.65 ± 1.04 mm |
| **Probing Depth** | | 1.88 ± 0.86 mm |
| **Periimplant bone level** | | 2.52 ± 1.16 mm |

| | | |
|---|---|---|
| **Number of implants per patient** | | 3.64 ± 1.46 Implants |
| **Localization** | Maxilla | 11 Implants |
| | Mandible | 80 Implants |
| **Amount of keratinized mucosa** | Absent | 18 Implants |
| | 1 mm | 28 Implants |
| | 2 mm | 33 Implants |
| | 3 mm or more | 12 Implants |
| **Biofilm Index** | 0 | 15 Implants |
| | 1 | 4 Implants |
| | 2 | 60 Implants |
| | 3 | 12 Implants |
| **Periimplant inflammation index** | 0 | 45 Implants |
| | 1 | 39 Implants |
| | 2 | 7 Implants |
| | 3 | 0 Implants |
| **Bleeding on probing** | Absent | 36 Implants |
| | Present | 55 Implants |

**Table 3:** Occlusal clinical parameters

| Clinical parameter | Average ± sd / Frequence |
|---|---|
| **Favorable Occlusion** | 51 (56.04%) |
| **Parafunctional Habits** | 14 (15.38%) |
| **Absence of occlusion** | 2 (2.19%) |
| **Premature contact** | 1 (1.09%) |

**Table 4:** Prevalence of complications

| **Complication** | Number of events (Frequence) |
|---|---|
| **Peri-implantitis** | 8 (8.79%) |
| **Bone level higher than 2mm** | 56 (61.53%) |
| **Absence of contact point** | 23 (25.27%) |
| **Screw fracture** | 2 (2.19%) |
| **Screw loosening** | 14 (15.38%) |
| **Ceramics fracture** | 2 (2.19%) |
| **Infrastructure fracture** | 1 (1.09%) |
| **Occlusal wear** | 5 (5.49%) |
| **Radiographic maladaptation** | 5 (5.49%) |

**Table 5:** Relative risk assessment of risk indicators of biological and mechanical complications.

| **Risk indicator** | **Frequence** | **Chi-square test (p)** | **Relative risk** | **Confidence interval** |
|---|---|---|---|---|
| **Mechanical complications** | | | | |
| Biofilm Index | | | | |
| *Present* | 40 (52.63 %) | 0.02 | 2.63 | 0.93 – 7.40 |
| *Absent* | 3 (20.0 %) | | | |
| Antagonist | | | | |
| *Tooth* | 30 (52.54 %) | 0.04 | 1.68 | 0.95-2.96 |

| | | | | |
|---|---|---|---|---|
| *Prosthesis* | 10 (31.25 %) | | | |
| **Biological complications** | | | | |
| Occlusion | | | | |
| *Favorable* | 14 (35.00 %) | < 0.001 | 2.29 | 1.47-3.57 |
| *Unfavorable* | 41 (80.39 %) | | | |
| Antagonist | | | | |
| *Tooth* | 29 (49.15 %) | < 0.001 | 5.82 | 4.31-7.85 |
| *Prosthesis* | 27 (84.37 %) | | | |

# Capítulo 2

**Original paper:** ***Comparison of the clinical outcomes in metalloceramic and metal-free restorations supported by dental implants. A case-control study.***

Eduardo Tadashi Pinto Emi, DDS, pHD[1] ; Guilherme José Pimentel Lopes de Oliveira, DDS, pHD [2]; Paulo Cezar Simamoto Junior, DDS, pHD [2]; Roberto Sales e Pessoa, DDS, pHD [2,3]

[1] Phd, Dental School; Universidade Federal de Uberlândia (UFU)

[2] Assistant Professor, Dental School; Universidade Federal de Uberlândia (UFU)

[3] Assistant Professor, Dental School; Centro Universitário do Triângulo (Unitri)

Author for Correspondance

Roberto Salles Pessoa

R. Olegário Maciel, 818 - Centro, Uberlândia - MG, Zip Code 38400-084

Phone: +55 (34) 3210-6446 email: rp@inpes.com.br

**ABSTRACT**

The aim of this retrospective clinical study was to compare the clinical outcomes of partial protheses supported by dental implants in the posterior region of the mouth constructed with metal-ceramic or metal-free restorations with at least 2 years of follow-up. Fifty patients were enrolled in this study. Twenty-five patients presented partial splinted metalloceramic prosthesis supported by cylindrical implants with external hexagon connection type, and confectioned over calcinable UCLA abutments , while the other group has twenty-five patients who presented partial splinted with hexagonal external and zirconia prothesis made in Cad/Cam. The STROBE protocol for retrospective clinical studies was used as a guide to conduct this research. Clinical, radiographic, bite potency and satisfaction surveys were performed for all patients. The implants restored with metal-free prosthesis presented lower periimplant bone level, biofilm accumulation, less mucosal inflammation and bleeding on probing than the implants restored with metalloceramic prosthesis (Table 2). Furthermore, the implants restored with zirconia presented protheses with a mora favorable occlusion pattern (Table 3) and less frequency of implants with bone level higher than 2 mm and less screw loosening the implants restored with metalloceramic crowns.

## INTRODUCTION

Studies have shown that restorative material used in rehabilitation directly influences peri-implant health, aesthetics, and resistance to biomechanical loads (Araujo, 2018). Metalloceramic prostheses are still the most widely used and considered the gold standard due to their excellent biomechanical properties and the extensive longitudinal follow-up information accumulated over the years (Pjetursson, 2004). However, the metal structure may compromise the periodontal tissue healthy, and may cause allergic reactions and aesthetic problems, especially in a thin periodontal phenotype where gingival margin color changes (Al Refai R, 2018)).

Faced with such clinical complications related to metalloceramic crowns, the metal-free restorations have been recentely proposed an alternative of treatment due to its optimal aesthetic features, suitable mechanical performance, and acceptable marginal fit in prostheses supported by teeth or dental implants. In this way, the increased demand for the combination between longevity and esthetical results, stimulated the development of better metal-free materials with higher survival rates (Takaba, 2013). Zirconia presents satisfactory esthetical performance and better mechanical properties when compared to others ceramics since it presents flexural strength of 900-1200 MPa, and compression resistance of about 2000 MPa. (Manicone, 2007). Zirconia's restorations have been widely indicated, either in its monolithic or veneered form, for single and fixed-partial dentures (FPD), copings and infrastructure even in dental or implant rehabilitations (Pjetursson, 2018 ).

One of the most challenging clinical situations is the rehabilitation of single and multiple edentulous spaces in the posterior region with diminished prosthetic space, insufficient interoclusal distance in regions where the implants were placed at the supra or at the level of the bony crest. In these cases, the UCLA-type abutment has been indicated for the prosthetic resolution since these abutments connect directly to the implant platform, which may aid in the resolution of the aforementioned clinical problems (Camargos et al., 2016).

Despite the high potential for resolution of several prosthetic clinical conditions, UCLA-type abutments have been associated with problems such as screw loosening or fracture, peri-implant bone loss and periimplantis (Vetromilla et al., 2018). These failures were related with the need for high temperatures for the preparation of the prosthesis during the firing of ceramic, which induces the misadjustment in calcinable UCLA abutments (Neves et al., 2014).

The laboratory steps of CAD / CAM consist of the digitization of molds or plaster models obtained by the dental surgeon, through which virtual models are generated that enable the design or design of future prostheses (CAM) (Drago, 2006; das Neves, 2015). In order to materialize these drawings or projects, a milling machine reads the binary data provided by CAM, which will guide the wearing of ceramic blocks, making it possible to obtain and deliver the prosthesis in a short period of time with a single specialized workforce (Beuer F. ,2008). Depending on the laboratory CAD / CAM system, the milling of several prosthesis designs from different patients can be milled in a single ceramic block, which offers credibility to the system.

The use of implant-supported fixed prostheses has been successful in rehabilitating partially edentulous areas. A systematic review showed a survival rate of 89.1% for conventional dental support metal-ceramic prostheses compared with 86.1% for implants supported over 10 years (Pjetursson, 2007). However, the literature is scarce of data that reports the survival and success of implant-supported metal-ceramic prostheses when compared to totally ceramic ones. Therefore, this retrospective study aimed to evaluate and compare the outcome of implant-supported partial prothesis constructed with zirconia and metallo-ceramic prosthesis in the posterior region with at least 2 years of follow-up. The study null hypothesis was that different restauration types do not influence clinical, biological and biomechanical aspects in a long term evaluation.

## MATERIAL AND METHODS

### *Study design*

The conduction of this study was approved by the ethical committee for human research of our institution under the protocol CAAE 63911616.9.0000.5152. All patients who participated in this study read and signed the informed consent form. A total of fifty patients have been enrolled in this study. Twenty-five patients presented partial splinted metalloceramic prosthesis supported by cylindrical implants with external hexagon connection type (TryOn, SIN Implant System, Sao Paulo, Brazil), and confectioned over calcinable UCLA abutments , while the other group has twenty-five patients who likely presented partial splinted implant-supported crows over external hex implants ( TryOn, SIN Implant System, São Paulo, Brazil), however confeccioned with zirconia made in Cad/Cam (Zirkonzhan, Gais, Germany).

The STROBE protocol for retrospective clinical studies was used as a guide to conduct this research. To participate in this research, patients should present at least one partial-prosthesis in the posterior region of the mouth supported by implants with external hexagon connection restored with zirconia or metal-ceramic prothesis with at least 2-year follow-up after the prosthesis installation.

***Clinical analysis***

The following clinical analysis was performed: Analysis of the peri-implant tissues: I) Biofilm index; II) Periimplant inflammation index; III) Keratinized mucosal length ; IV) Keratinized mucosa thickness ; IV) Bleeding on probing; V) Probing Depth; VI) Number of implants per patients; and VII) Diagnosis of periimplantitis (Bone loss higher than 2 mm associated with bleeding on probing). Analysis of the prosthetic conditions: I) Absence of contact point; II) Screw fracture or loosening; III) ceramic fracture; IV) Infrastructure fracture; V) Occlusal wear; VI) Radiographic maladaptation; VII) Parafunctional habits; VIII) Absence of occlusion; and IX) presence of premature contact.

***Radiographic Analysis***

Digital periapical radiographs were made in all patients to evaluate marginal adaptation and peri-implant bone level. To perform the radiographic examination, digital X-ray and positioners (Cone Indicator, Indusbello, Londrina, Paraná, Brazil) adapted to the digital sensor were used so that the X-ray beam was perpendicular to implant crestal module. The images were captured at the exam. Radiographic examinations evaluated bone loss and marginal maladaptation.

**Masticatory power analysis**

A digital Gnatodynamometer (Kratos Digital Dynamometer model DDK, Kratos Equipamentos Industriais Ltda., Cotia, Sao Paulo, Brazil) was used to measure the occlusal load. The patient remains seated, with the head relaxed and the plan of Frankfort were maintained parallel to the ground. The load cell fork was positioned between upper and lower arch at first molar height. Five bites were performed on each side with a time interval of 3 minutes. The average of this measurements was considered the masticatory force data.

**Quality of life analysis**

Patients indicated their overall satisfaction regarding the prosthesis by a single response marked on the OHIP-14 that is a subjective indicator that aims to provide a measure of disability, discomfort and disadvantage (attributed to oral condition through self-assessment). OHIP-14 contains only 14 items, was described by Slade in 1997. This version integrates only two questions for each of the seven dimensions: Functional Limitation, Physical Pain, Psychological Discomfort, Physical Disability, Psychological Disability, Social Disability, and Disadvantage.

***Statistical Analysis***

The Graphpad Prism 6 software (San Diego, CA, USA) was used to perform the statistical analysis. All the statistical tests were applied at the significance level set at 5 %. All the numeric data were parametric (Keratinized mucosal length; Keratinized mucosa thickness; Probing Depth; Number of implants per patients; Periimplant bone level; Masticatory force, and OHIP-14) and then the unpaired t-test was used for the inferential comparison between the metalloceramic and metal-free groups. The chi-square test was used for the

comparison of the dichotomic data between the metalloceramic and metal-free groups (Bleeding on probing; Diagnosis of periimplantitis; Absence of contact point; Screw fracture of loosening; Ceramic fracture; Infrastructure fracture; Occlusal wear; Radiographic maladaptation; Parafunctional habits; Absence of occlusion; and presence of premature contact).

## RESULTS

A total of 178 implants was placed in 50 patients (20 male and 30 females, with no differences regarding the gender distribution between the groups). Ninety-one implants placed received a metal-ceramic prothesis confeccioned with calcionable UCLA abutments, while 87 implants received a zirconia abutment that was manufactured with the aid of the CAD-CAM system, directly over implant platforms. All the implants placed were involved in screwed-partial fixed prosthesis in the posterior region of the mouth. The implants characteristics is exposed at the Table 1.

The implants restored with metal-free prosthesis presented lower levels of periimplant bone loss, biofilm accumulation, mucosal inflammation and bleeding on probing than the implants restored with metalloceramic prosthesis (Table 2). Furthermore, the implants restored with zirconia presented protheses with more favorable occlusion patterns (Table 3) and less screw loosening then implants restored with metalloceramic crows (Table 4).

## DISCUSSION

The present research work was designed to evaluate clinical, biological and biomechanical aspects of long-term implant-supported partial fixed posterior rehabilitation, comparing metallo-ceramic confeccioned over

UCLA abutment and zirconia performed by CAD-CAM system. The current data have shown that both metal-ceramic and zirconia implant-supported prothesis presented high rates of success and survival after two-years of follow up. However, the zirconia rehabilitations presented less biofilm accumulation, peri-implantitis prevalence, bleeding on probing, bone loss, point of contact loss, and screw loosening than the metalloceramic rehabilitations.

The biofilm accumulation at the implant-prosthetic interface was the main biological complication finding in this study. A total of 46 implants restored with zirconia presented the absence of biofilm accumulation in 86 installed implants while only 15 implants rehabilitated with metalloceramic prosthesis presented no biofilm accumulation in 90 installed implants. A greater amount of biofilm accumulation was found in metalloceramic prostheses when compared to zirconia prostheses. This fact may be related to the less adherence of biofilms on zirconia compared with other materials, as demonstrated in previous studies (Mathew MG, 2020). Consequently, a smaller prevalence of peri-implant inflammation was also demonstrated for zirconia rehabilitations. However, it is difficult to determinates whether less biofilme accumulation for zirconia was related to the material superficial smoothness or better implant-abutment adaptation conferred by making protheses using a CAD/CAM system (Memari Y, 2018**)**. More studies are necessary to elucidate those aspects on bacterial biofilm accumulation.

In the current research work, the zirconia rehabilitations presented lower levels of bone loss compared with the metallo-ceramic prostheses. This was probably due to the higher accuracy of the CAD/CAM system that was used to panned the zirconia protheses in this study. The concept of direct

screw-retention at the implant level is widely used in CAD/CAM prostheses, but require careful planning with a favorable implant axis and a good implant distribution (Worn, 2015). The stability of the component used for retention of the prosthesis to the implant is considered extremely important for the longevity of the restorations (Koutouzis T,2019) It has been showed that the precisi(on of the adaptation of the rehabilitation manufactured by the CAD/CAM system provided lesser prosthetic and biological complications (Fabri, 2017). This may be due to the automated and accurate workflow in CAD/CAM; it is a faster method that can prevent errors that occur during investment, wax removal, casting, finishing, and polishing for conventional casting, as well as reduces the possibility of an error during the contraction of acrylic resin patterns (de Franca, 2016).

In the same way, it was also noted that the metallo-ceramic protheses presented more screw loosening and absence of contact point than the zirconia prosthesis. Again the more accurate implant-abutment adaptation provided by the digital CAD/CAM workflow, more than the material used to manufacture the rehabilitations, was probably responsible for the observed resutls. The accuracy of fit at the abutment-implant interface on the horizontal axis can be achieved by correct alignment of the prosthesis to the implant axis and by obtaining an equal diameter in the contact area of the prosthesis-implant (Kolgeci, 2014**)** Failures relating to implant-abutment alignment could influence the stress concentration in the abutment screw and cause early loss of torque and absence of contact point. In addition, it has bee demonstrated that the mechanical properties of zirconia's hardness and resilience positively influence the contact point (Chander, 2018).

Some authors suggested that implant-abutment micro-gap size and abutment stability are also a factors that may influence the magnitude of early peri-implant bone loss, due to the microleakage that occurs through these microgaps. The degree of leakage is dependent on the type of abutment connection, the gap size, and the amount of micromovement (Koutouzis et al. 2014. Fernández et al. argued that a suitable milling process has a greater potential to generate smoother prosthetic surfaces compared with conventionally cast frameworks, which promotes a larger contact area between the implant and component (Fernandez, 2014). A larger and stable implant-abutment interface results in a greater area for loading dissipation on the implant platform and thus in a smaller stress/strain concentration in the implant–abutment interface (Pessoa et al. 2014). The higher abutment instability, as a result of a possible greater implant-abutment misfit in metallo-ceramic UCLA protheses, may also contributed to the observed differences on peri-implant bone loss between the evaluated rehabilitation types (Pessoa et al., 2017).

Some authors recommended caution when zirconia is used in direct contact with the implant platform, because of the irreversible changes may occur in the implant platform, depending on the torque applied to the abutment-retaining screw and when the excessive occlusal forces over the time, (Queiroz, 2019). However,

A more frequently mentioned risk of failure of zirconia-based FDPs, whether tooth- or implant-supported, is chipping of the veneering material (Triawattana 2012). By means of microscopic techniques, the type of veneering surface loss, whether chipping within the layered material or complete loosening from the core material, can be described. Sometimes this distinction is difficult

to make clinically if only a small area is involved, and therefore this technical complication is different from chipping in metal-ceramic prostheses, where the dark shine of the metal becomes visible. Thus, some patients may not be aware of minor chipping as long as crown shape and color do not change.

The higher level of bone loss and periimplantitis in the metalloceramic rehabilitations supported by UCLA system needs to be investigated. Implant-abutment/implant-prosthesis connection is being investigated clinically and in laboratory studies. As no abutments were used in the present study, the contact zone between the zirconia framework and implant shoulder had a flat-to-flat design. The opening of the micro gap between implant and superstructure under functional load is regarded as a biological problem, resulting in a quick internal bacterial colonization of the implant through the pumping effect (Mahn, 2019**)**

Some studies used patient satisfaction as a criterion of success for different implant-supported rehabilitations (Shi, 2016) In the present study, the patients' satisfaction index was similar and satisfactory in OHIP 14, comparing zirconia and metal-ceramic. The clinical and radiographic differences between the two groups were imperceptible to patients, and in the both groups, patient satisfaction level was completely met. However, these criteria are subjective, since external factors not related to ceramic material and final restoration could be taken into account, for example, time spent and surgical troubles.

Within the limitations of this retrospective study, it could be concluded that zirconia offers a suitable option of treatment for metal-free restorations with high survival rates and a high patient satisfaction rate.

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**Table 1:** Implant characteristics

| Characteristcs | Type | UCLA | CAD-CAM |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **Implant lengh** | 7 mm | 1 Implants | 1 | 6 Implants |
| | 8.5 mm | 1 Implants | 3 | 5 Implants |
| | 10 mm | 1 Implants | 6 | 29 Implants |
| | 11 mm | 3 Implants | | - |
| | 11.5 mm | 2 Implants | 8 | 26 Implants |
| | 13 mm | 2 Implants | 0 | 21 Implants |
| **Implant diameter** | 3.75 mm | 7 Implants | 3 | 76 Implants |
| | 4.00 mm | 1 Implants | 3 | 7 Implants |
| | 5.00 mm | 5 Implants | | 2 Implants |
| **Plataform diamater** | 4.10 mm | 8 Implants | 6 | 85 Implants |
| | 5.00 mm | 5 Implants | | 2 Implants |

**Table 2:** Periimplant clinical parameters

| Clinical Parameters | Score | UCLA | CAD-CAM |
|---|---|---|---|
| **Keratinized mucosa length** | | 2.46 ± 0.92 mm | 2.30 ± 1.25 mm |
| **Keratinized mucosa thickness** | | 1.65 ± 1.04 mm | 1.64 ± 1.20 mm |
| **Probing Depth** | | 1.88 ± 0.86 mm | 1.58 ± 0.82 mm |
| **Periimplant bone level** | | 2.52 ± 1.16 mm | 2.04 ± 0.74 mm* |
| **Number of implants per patient** | | 3.64 ± 1.46 Implants | 3.39 ± 1.33 Implants |
| **Masticatory Force** | | 190.1 ± 95.60 N | 196.8 ± 95.60 N |
| **OHIP 14** | | 0.84 ± 1.64 | 0.43 ± 0.63 |
| **Localization** | Maxilla | 11 Implants | 29 Implants |
| | Mandible | 80 Implants | 58 Implants |
| **Amount of keratinized mucosa** | Absent | 18 Implants | 13 Implants |
| | 1 mm | 28 Implants | 34 Implants |
| | 2 mm | 33 Implants | 17 Implants |
| | 3 mm or more | 12 Implants | 23 Implants |
| **Biofilm Index** | 0 | 15 Implants | 46 Implants* |
| | 1 | 4 Implants | 3 Implants |
| | 2 | 60 Implants | 38 Implants |
| | 3 | 12 Implants | 0 Implants |
| **Periimplant inflammation index** | 0 | 45 Implants | 63 Implants* |
| | 1 | 39 Implants | 22 Implants |
| | 2 | 7 Implants | 2 Implants |
| | 3 | 0 Implants | 0 Implants |
| **Bleeding on probing** | Absent | 36 Implants | 70 Implants* |

| | | | |
|---|---|---|---|
| | Present | 55 Implants | 17 Implants |

**Table 3:** Occlusal clinical parameters

| Clinical parameter | UCLA | CAD-CAM |
|---|---|---|
| **Favorable Occlusion** | 51 (56.04%) | 73(83.90 %)* |
| **Parafunctional Habits** | 14 (15.38%) | 7 (8.04%) |
| **Absence of occlusion** | 2 (2.19%) | 7 (8.04%) |
| **Premature contact** | 1 (1.09%) | 0 (0.00%) |

**Table 4:** Prevalence of complications

| Complication | UCLA | CAD-CAM |
|---|---|---|
| **Peri-implantitis** | 8 (8.79%) | 5 (5.74%) |
| **Bone level higher than 2mm** | 56 (61.53%) | 20 (22.98%)* |
| **Absence of contact point** | 23 (25.27%) | 7 (8.04%)* |
| **Screw fracture** | 2 (2.19%) | 0 (0.00%) |
| **Screw loosening** | 14 (15.38%) | 7 (8.04%)* |
| **Ceramics fracture** | 2 (2.19%) | 2 (2.29%) |
| **Infrastructure fracture** | 1 (1.09%) | 5 (5.74%) |
| **Occlusal wear** | 5 (5.49%) | 5 (5.74%) |
| **Radiographic maladaptation** | 5 (5.49%) | 3 (3.44%) |

# Capítulo 3

## Zirconia CAD/CAM implant-supported restorations: A 2-year retrospective study

Eduardo Tadashi Pinto Emi[1] Julia Dantas Mazão [3] Caio Dias Resende[3] Taís Alves dos Reis[4] Célio Jesus Prado[5] Roberto Sales e Pessoa[6] Flávio Domingues das Neves[7] Paulo Cézar Simamoto

[1] DDS, MS student, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia.
[2] DDS, PhD student, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia
[3] DDS, MS student, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia.
[4] DDS, PhD student, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia
[5] DDS, PhD student, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia
[6] DDS, PhD, Department of Periodontology, Centro Universitario do Triangulo
[7] DDS, PhD, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia.
[8] DDS, PhD, Department of Occlusion, Fixed Prosthesis and Dental Materials, School of Dentistry, Federal University of Uberlândia.

* Corresponding author:

Professor Paulo Cezar Simamoto Júnior

Avenida Pará, No. 1720, Bloco 4L, Anexo A, Sala 4LA-42, 38405-320, Uberlândia, MG,

Brazil.

E-mail: psimamoto@foufu.ufu.br

**ABSTRACT**

**Objectives:** The aim of this retrospective study was to evaluate the success rate and the influence of technical, biological and occlusal factors at zirconia-implant restorations obtained by Zirkonzahn CAD/CAM system performed in a dentistry postgraduate school with at least 2 years of follow-up.

**Methods:** Two experience prosthodontics researchers without any relationship with the school and working in pairs analyzed and rated all patients. Data were collected regarding following a modified United States Public Health (USPHS) parameters and restoration design (single, FPD or complete-arch); antagonist teeth characteristics; implant connection (external hexagon; internal hexagon and Morse taper); prostheses retained (cemented or screwed). Biological, occlusal outcomes and patient satisfactions were also observed. Success functions of the restorations were estimated nonparametrically according to the curve Kaplan-Meier method.

**Results:** A total of 49 patients and 124 zirconia CAD/CAM implant prosthesis were evaluated, after a mean observation period of 33.04±5.7 months. The Kaplan Meier survival rate was 90.9% for single, 84.9% for FPD restorations and 100% for complete-arch implant-supported restorations. The most common complications were fracture of framework and chipping. The overall patients' satisfaction with the treatment was 8.1 (±2,1).

**Conclusion:** Within the limitations of this retrospective study, it can be concluded that zirconia CAD/CAM implant prosthesis offers a suitable option of treatment to metal-free restorations with a high survival rates. The occlusal situation of the patient is directly associated with the success of the restoration.

**Key words:** zirconia, retrospective study, survival rate, fixed implant prosthesis.

## INTRODUCTION

Metal-free restorations emerged in Dentistry as an option of treatment with optimal aesthetic features, suitable mechanical performance and acceptable marginal fit, even in dental or implant prostheses. The increased demand of this treatment developed better materials with higher survival rates.[1] Advances in CAD/CAM technology have catalyzed the developments of high strength polycrystalline ceramics, such as zirconia, that could not be processed by traditional laboratory methods.[2] Zirconia presents satisfactory performance and better mechanical properties, when compared to other ceramics, with the flexural strength of 900-1200 MPa and compression resistance about 2000 MPa. [3,4]

Due to the opaque[4-7] appearance of the first generation zirconia, it is usual to cover the restoration with a glass-ceramic for satisfactory aesthetics, in aesthetic areas. However, the most common problem of covered zirconia restoration is the chipping of the veneer.[8] This complication occurs more often in zirconia rehabilitations than in metal-based fixed dental prostheses.[7,9,10] Therefore, improvement at optical properties introduced new shades of monolithic zirconia for more satisfactory aesthetic in critical restorations.[5,11] Polychrome zirconia could be colored with several stains before the sintering process,[5] and used by some CAD/CAM zirconia systems, such as Zirkonzahn (Zirkonzahn).

Zirconia's restorations have been widely indicated, either in its monolithic or veneered form, for single and fixed-partial dentures (FPD),

copings and infrastructure even in dental or implant prostheses. Several factors contribute to longevity of restorations, such as the precision fit. Morphology of the tooth or cavity preparation, setting up the system design and machining, the type of CAD/ CAM (direct at chairside or indirect at laboratory), the assembly and material and the experience of the operator can interfere at precision fit of CAD/CAM restorations. {Keshvad, 2011 #36} Values of 10 μm are clinical acceptable for implant-supported prostheses to avoid biological complications;[12] Thus, investigate restorations made by different CAD/CAM systems and different materials.it is still important.

Therefore, the aim of this retrospective study was to evaluate the outcome of zirconia CAD/CAM implant-supported restorations performed in a dentistry postgraduate school, with at least 2 years of follow-up. The hypothesis of this study was that technical, biological and occlusal factors affect the survival rate of restorations.

## MATERIAL AND METHODS

The study protocol was approved by Ethical Committee from Federal University of Uberlandia (1.627.881) before started. The inclusion criteria were patients that had received single, FPD or complete-arch CAD/CAM implant-supported restorations between 2013 and 2014 at a postgraduate school (INPES-Uberlândia, MG, Brazil). All patients for this retrospective study were obtained by checking the dental records of the postgraduate school and they were informed, according to the Informed Consent Form, that could withdraw the study any time and without any explanation.

Two experience prosthodontics researchers without any relationship with the school evaluated all patients. All restorations were made by one CAD/CAM laboratorial system (Zirkonzahn M5, Zirkonzahn). Data were collected regarding following a modified United States Public Health (USPHS) parameters and restoration design (single, FPD or complete-arch); antagonist teeth characteristics; implant connection (external hexagon; internal hexagon and Morse taper); prostheses retained (cemented or screwed) and implant abutment used. Biological, occlusal evaluation and patient satisfaction was also recorded.

***Technical evaluation***

For technical evaluation of zirconia CAD/CAM implant-supported restorations, a modified United States Public Health Service (USPHS) criteria were used (Table 1). These criteria analyzed framework fracture, veneering fracture, occlusal wear, marginal adaptation and anatomical form. Screws behavior of the abutment and prostheses or loss of retention of cemented restorations was also observed. Only catastrophic failures (rate “Charlie”) were considered events.

***Biological evaluation***

Biological evaluations were made with a probing pocket depth (PPD)[13] and bleeding on probing (BOP)[13] measured with a periodontal probe (UNC-15 Periodontal Probe; Hu-Friedy). Absence or presence of visible plaque and presence of mucositis was also recorded.

***Occlusal Evaluation***

The occlusion factors were evaluated as favorable or unfavorable. Class II or III malocclusion; anterior or posterior crossbite; open bite; edge to edge; absence of anterior guide; absence of interocclusal contact and parafunctional habits were considered unfavorable occlusal relationships.[14] The condition of the prosthesis in occlusal situation was also evaluated.

***Patient satisfaction***

The patients indicated their overall satisfaction of zirconia implant prosthesis on a visual analogue scale (VAS) from 0 to 10, with 100 mm of length. After the point assigned by the patient, it was measured and the percentage was determined comparing of all length.

**RESULTS**

Sixty four patients were contacted: 13 were interest to participate, but not at that time; two refused. Forty nine patients attended the appointment. Thirty women and 19 men were treated with 135 prostheses, whether single, FPD or complete-arch distributed over 259 implants (Table 2). The mean age of patients was 56±11.3 year-old. The mean observation time of the prosthesis was 33±5.69 months. The survival rate was 90.9% for single crowns, 84.9% for FPD restorations and 100% for complete-arch implant-supported restorations. Main characteristics of single and FPD prostheses are described on Table 3 and 4, respectively.

Six complete-arch implant-supported restorations were distributed over 40 implants and were also evaluated. Thirty six were located at maxilla and 4 at mandible; screw retained and partial veneered at facial surface. Twenty-three implants were External Hexagon and 17 were Morse taper implant.

***Technical Evaluation***

After the observation time of single prostheses, 3 (9%) prostheses presented rate “Charlie” (C), all anatomical form problems. Modified USPHS ratings for single restorations are presented in Table 5. When FPD prostheses were evaluated, 13 restorations were “Charlie” (C), and the major cause of failure was framework fracture. The results of modified USPHS ratings to FPD restorations are presented in Table 6.

For complete-arch implant-supported restorations, no framework fracture was found. One prosthesis presented chipping of the veneering porcelain but considered clinically acceptable (“Bravo” – B). All prostheses presented satisfactory rate for occlusal wear, marginal adaptation and anatomical form.

***Biological evaluation***

The biological evaluation (plaque index, bleeding on probing and mucositis) is available on table 7 of all restorations. Mucositis did not cause catastrophic failures. Patients who presented mucositis were treated. All lesions regressed and they were discharged.

***Occlusal Evaluation***

Occlusal evaluation of all prostheses demonstrated that 39 (80%) patients presented favorable occlusal. Three (6%) patients presented absence of anterior guide; 1 (2%) presented crossbite and 4 (8%) presented parafunctional habits. Edge to edge bite was observed in 1 (2%) patient and another 1 (2%) presented absence of interocclusal contact.

### *Failures Description*

Two hundred and forty seven screws connected 124 screwed prostheses over implants. Fifty-nine (24%) were loosened. Three prostheses that had a loosened screw also had technical failures: 2 were framework fractures (board fracture) and 1 was anatomical failure. No loss of retention of cemented restorations was found. Twelve (13%) failures were found: 3 in single (Table 8) and 9 in FPD prostheses (Table 9). No catastrophic failures were found at complete-arch implant-supported restorations.

### *Patient satisfaction*

Based on a 10-point VAS the mean value of patient satisfaction with evaluated prosthesis were 8.1 (±2.1).

### *Statistical Analyses*

The estimated Kaplan-Meier survival rate for single restorations was 91% (Figure 1) and 85% for FPD restorations (Figure 2). For complete-arch implant-supported restorations, the survival rate was 100%.

## DISCUSSION

Zirconia restorations demonstrated satisfactory results after a mean observation period of 33±5.69 months. Recent studies that did not excluded patients with unfavorable occlusion demonstrated similar survival rates.[14,15] The main failures presented in this study are directly related to technical and occlusal factors: framework fracture, anatomical form failures, chipping and lack of precision fit. Kaplan-Meier curve analyses indicated a high number of failures in the first year of evaluation. Time, although very important, may not be a

determining factor for ceramic failure. If the material early fails, it might be more associated with material weakness or errors during the fabrication process.[10,16] All restorations of this study were produced by one CAD/CAM laboratorial system (Zirkonzahn M5, Zirkonzahn).

The concept of direct screw-retention at the implant level is widely used in CAD/CAM prostheses but require careful planning with a favorable implant axis and a good implant distribution.[15] The stability of the component used for retention of the prosthesis to the implant is considered extremely important for the longevity of the restorations.[17,18] In this study, four fractures were found in board region (Figure 3), all made directly from the implant (UCLA) and 75% presented loosened screws. This situation may have contributed to board fracture found. A framework fracture occurred at a 4-unit FPD (figure 4). The fracture was at the connector area, that represents the *locus minoris resitentiae*, where is located the highest stress during occlusal loading.[19] This FPD was being used to increase the vertical dimension of patient which could increase the stress in this area.

Clinical and laboratorial studies demonstrate that one of the most frequent complications in zirconia restorations is the occurrence of chipping of the veneering.[14,19,20] Two (33%) cases of chipping were seen in partial restorations. In both cases, patients did not present favorable occlusal, confirming the relationship between failures and malocclusion. Higher chipping in porcelain veneer was observed in patients without favorable occlusal.[14] In this situation, the use monolithic zirconia crowns with sophisticated coloring and staining techniques allows better color match.[5] In this study, aesthetical failures were related to anatomical failures (anatomical shape or loss of proximal

contact) and not to material (monolithic or veneering). Therefore, monolithic restorations are an alternative to patients without favorable occlusal even in aesthetic areas.

Plaque index at implant-prosthetic interface was the main biological failures found in this study. Despite not presenting plaque at restoration surface, 26 (49%) FDP restorations presented visible plaque after removal. Three patients presented mucositis, without catastrophic failures. It could be related to the increased internal prosthetic space, lack of precision fit, low extension of keratinized mucosa and poor hygiene. More studies are necessary to elucidate the effect of zirconia on bacterial plaque accumulation.[21]

Some studies use patient´s satisfaction as a criterion of success, demonstrating that the restorations in zirconia bring function and aesthetic. [22-24] In the present study, the patients' satisfaction index was 8.1, lower when compared to aforementioned studies. However, these criteria are subjective, since external factors not related to ceramic material and final restoration could be taken into account. In a post-graduate school, the patients are attended once a month. So, the time spent during rehabilitation process may have influenced the results.

Within the limitations of this retrospective study, it could be concluded that zirconia offers a suitable option of treatment to metal-free restorations with a high survival rates. The occlusal situation of the patient is directly associated with the survival of the restoration.

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**FIGURES**

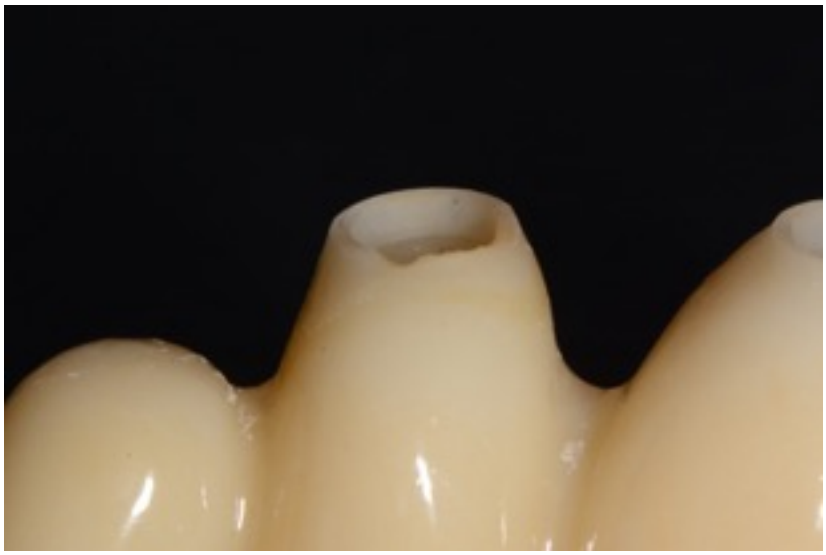

**Figura 1 - Board fracture.**

**Figura 2 - Framework at a 4-unit FPD.**

## TABLES

**Table 1.** Modified USPHS criteria.

| | Alpha (A) | Bravo (B) | Charlie (C) |
|---|---|---|---|
| Framework fracture | No fracture | - | Fracture |
| Veneering Porcelain Fracture | No fracture | Fracture, but polishing possible | Chipping down the framework. New reconstruction is needed |
| Occlusal Wear | No occlusal wear on reconstruction or on opposite teeth | Occlusal wear on reconstruction or on opposite teeth < 2 mm | Occlusal wear on reconstruction or on opposite teeth > 2 mm. New reconstruction is needed |
| Marginal adaptation | No probe catch | Slight probe catch, but no gap | Gap with some dentine or cement exposure. New reconstruction is needed |
| Anatomical form | Ideal anatomical shape, good proximal contact | Slightly over- or under-contoured, weak proximal contact | Highly over- or under-contoured, open proximal contact. New reconstruction is needed |

**Table 2.** Description of type of restoration evaluated.

| Type of restoration | Number/Percentage |
|---|---|
| Single | 43 (35%) |
| FPD | 75 (60%) |
| Complete-arch | 6 (5%) |

**Table 3.** Description of single crowns restoration.

| | | |
|---|---|---|
| Distribution of the restoration | Anterior maxilla | 19 (44,1%) |
| | Posterior maxilla | 16 (37,2%) |
| | Anterior jaw | 0 |
| | Posterior jaw | 8 (18,6%) |
| Type of restorative material | Monolithic | 27 (62,7) |
| | Veneering | 16 (37,2%) |
| Type of retention | Screwed | 21 (48,8%) |
| | Cemented | 22 (51,2%) |
| Implant connection | HE | 17 (39,5%) |
| | Morse Taper | 25 (58,1%) |
| | HI | 1 (2,3%) |

**Table 4**. Description of FPD restoration.

| | | |
|---|---|---|
| Distribution of the restoration | Anterior maxilla | 5 (6,6%) |
| | Posterior maxilla | 20 (26,6%) |
| | Anterior jaw | 0 |
| | Posterior jaw | 50 (66,7%) |
| Type of restorative material | Monolithic | 68 (90,6%) |
| | Veneering | 7 (9,4%) |
| Type of retention | Screwed | 75(100%) |
| | Cemented | 0 |
| Implant connection | HE | 145 (81,4%) |
| | Morse Taper | 33 (18,6%) |
| | HI | 0 |

**Table 5.** Modified USPHS ratings to single restorations.

| | | |
|---|---|---|
| Framework fracture | Alfa | 43 |
| | Charlie | 0 |
| Veneering Porcelain Fracture | Alfa | 42 |
| | Bravo | 1 |
| | Charlie | 0 |
| Occlusal wear | Alfa | 42 |
| | Bravo | 1 |
| | Charlie | 0 |
| Marginal adaptation | Alfa | 40 |
| | Bravo | 3 |
| | Charlie | 0 |
| Anatomical form | Alfa | 37 |
| | Bravo | 3 |
| | Charlie | 3 |

**Table 6.** Modified USPHS ratings to FPD restorations.

| | | |
|---|---|---|
| Framework fracture | Alfa | 69 |
| | Charlie | 6 |
| Veneering Porcelain Fracture | Alfa | 70 |
| | Bravo | 2 |
| | Charlie | 3 |
| Occlusal wear | Alfa | 71 |
| | Bravo | 3 |
| | Charlie | 1 |
| Marginal adaptation | Alfa | 71 |
| | Bravo | 2 |
| | Charlie | 2 |
| Anatomical form | Alfa | 67 |
| | Bravo | 7 |
| | Charlie | 1 |

**Table 7.** Description of biological evaluation

| Type | No Visible Plaque | Visible Plaque | Punctual Bleeding | Linear Bleeding | Mucositis |
|---|---|---|---|---|---|
| Single | 28 (66%) | 15 (34%) | 3 (7%) | 2 (4%) | 4 (9%) |
| FPD | 41 (54,6%) | 34 (45,4%) | 10 (13%) | 7 (9%) | 8 (10%) |
| Complete-arch | 2 (33,3%) | 4 (66,7%) | 3 (50%) | 2 (33%) | 2 (33%) |

**Table 8.** Description of single zirconia CAD/CAM implant-supported restorations failures.

| Patient no. | Gender | Tooth | Junction | Material | Retention | Service Time (mo) | Oclusion | Reason for failure |
|---|---|---|---|---|---|---|---|---|
| 3 | M | 22 | Morse Taper | Veneering | Cemented | 37 | Absence of anterior guide | Anatomical form |
| 26 | F | 24 | Morse Taper | Monolithic | Screwed | 26 | Favorable | Anatomical form |
| 12 | M | 14 | External Hexagon | Monolithic | Screwed | 32 | Absence of anterior guide | Anatomical form |

**Table 9.** Description of FPD zirconia CAD/CAM implant-supported restorations failures.

| Patient no. | Gender | Units | Region | Junction | Material | Abutment | Service Time | Oclusion | Reason for failure |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 4 | Posterior | External Hexagon | Monolithic | UCLA | 40 | Absence of anterior guide | Framework Fracture |
| 2 | F | 2 | Posterior | External Hexagon | Monolithic | UCLA | 40 | Favorable | Anatomical form |
| 23 | F | 3 | Posterior | External Hexagon | Monolithic | UCLA | 29 | Favorable | Framework Fracture (Board fracture) |
| 23 | F | 3 | Posterior | External Hexagon | Monolithic | UCLA | 29 | Favorable | Marginal desadaptation |
| 9 | M | 2 | Posterior | External Hexagon | Monolithic | UCLA | 34 | Favorable | Framework Fracture (Board fracture) |
| 10 | M | 3 | Posterior | External Hexagon | Monolithic | UCLA | 32 | Absence of posterior stability by the absence of antagonist | Framework Fracture (Board fracture) |
| 5 | F | 7 | Anterior | Morse Taper | Veneering | Mini conical abutment | 27 | Edge to edge | Chipping |
| 12 | M | 4 | Anterior | Morse Taper | Veneering | Mini conical abutment | 32 | Absence of anterior guide | Chipping |
| 22 | F | 3 | Posterior | External Hexagon | Monolithic | UCLA | 27 | Favorable | Framework Fracture (Board fracture) |
| 40 | M | 5 | Posterior | External Hexagon | Monolithic | UCLA | 32 | Favorable | Framework Fracture |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 40 | M | 5 | Posterior | External Hexagon | Monolithic | UCLA | 32 | Favorable | Chipping |
| 35 | M | 11 | Posterior | External Hexagon | Monolithic | UCLA | 40 | Parafunctional Habits | Occlusal wear |
| 41 | F | 6 | Posterior | External Hexagon | Monolithic | UCLA | 32 | Parafunctional Habits | Occlusal wear |

# 5. CONSIDERAÇÕES FINAIS

Embora exista suporte na literatura que sustentam alternativas mais previsíveis do que a utilização de UCLA calcinável para reabilitações implanto-suportadas, os resultados de longo prazo deste tipo de pilar apresentaram-se satisfatórios e aceitáveis, principalmente relacionados a alta taxa de sobrevivência dos implantes. Por outro lado, um maior índice de acúmulo de placa, inflamação periimplantar e falhas protéticas pôde ser demonstrado para os pilares UCLA, quando comparados com a Zirconia monolítica confeccionada por CAD-CAM.

Neste sentido, a utilização da tecnologia para confecção de próteses sobre implante no sistema de CAD/CAM incorporam benefícios e aumento da previsibilidade nos tratamentos, proporcionando menores níveis de inflamação e perda óssea periimplanares, e complicações protéticas. A possibilidade de tornar os tratamentos mais seguros principalmente considerando as inflamações periimplantares é altamente benéfico, pois não existe consenso na literatura para o tratamento das periimplantites, sendo a prevenção a forma mais eficaz de combatê-la.

Ainda neste estudo, observou-se também que as próteses metalocerâmicas apresentaram mais afrouxamento do parafuso e ausência de ponto de contato que as próteses de zircônia. Sugere-se, que principalmente a adaptação mais precisa do implante-pilar fornecida pelo fluxo de trabalho digital CAD / CAM, inclusive mais do que o material utilizado para fabricar as reabilitações, provavelmente foi responsável pelos resultados observados.. Falhas relacionadas ao alinhamento implante-pilar podem influenciar a concentração de tensão no parafuso do pilar e causar perda precoce de torque e ausência de ponto de contato. Acredita-se que as propriedades mecânicas da dureza e resiliência da zircônia influenciam positivamente o ponto de contato (Chander, 2018).

Foi observado também que pacientes que apresentaram um bom controle da placa, obtiveram menores níveis de complicações, como perda de ponto de contato, afrouxamento de parafuso, perdas ósseas e periimplantites.

A Zirconia confeccionada pelo método CAD/CAM foi demonstrada como sendo um material que atende de maneira satisfatória as necessidades biomecânicas e estéticas da reabilitação implanto-suportada, apresentando menores níveis de acumulo e retenção de placa na coroa e na interface coroa/ implante. Isso influencia diretamente no sucesso e longevidade dos tratamentos. Além disso, o menor numero de complicações protéticas e periimplantares influencia diretamente na hora clinica do profissional que necessitará menos intervenções e retratamentos, aumentando a produtividade e diminuindo custos.

Mais estudos necessitam ser realizados para avaliar e comparar a eficiência do material em situações desafiadoras como: pacientes com envolvimentos sistêmicos, areas enxertadas, carga imediata e areas estéticas, com acompanhamentos prospectivos longitudinais.

# 6. CONCLUSÃO

Através desse trabalho conclui-se que:

- A reabilitação com UCLA apesar do índice relativamente alto de complicações protéticas e perimiplantares, apresentou-se como uma alternativa satisfatória de reabilitação em um intervalo de acompanhamento entre 4 à 10 anos.
- O risco relativo de complicações protéticas e periimplantares aumenta significativamente quando associado com: antagonista dente, oclusão desfavorável e presença de placa.
- A Zirconia é uma alternativa viável e previsível para reabilitar próteses sobre implante.
- As próteses confeccionadas em CAD/CAM em zirconia apresentam menor acumulo de biofilme, menor desaperto de parafuso, menor perda de ponto de contato e menos perda óssea periimplantar
- As proteses em zirconia confeccionadas em CAD/CAM, apresentaram alta taxa de sucesso e índice de satisfação dos pacientes, apresentando baixo índice de complicações protéticas

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