Analice Giovani Pereira

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Tese apresentada ao Programa de Pós-graduação da Faculdade de Odontologia da Universidade Federal de Uberlândia, para obtenção do título de Doutora em Odontologia na Área de Clínica Odontológica Integrada.

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Orientador: Prof. Dr. Paulo Vinícius Soares

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Prof. Dr. Mauro Pedrini Santamaria

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Ata da defesa de TESE DE DOUTORADO junto ao Programa de Pós-graduação em Odontologia Faculdade de Odontologia da Universidade Federal de Uberlândia.

Defesa de: Tese de Doutorado nº 010 - COPOD
Data: 26/11/2015
Discente: Analice Giovani Pereira; Matrícula: (11313ODO001)
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Projeto de Pesquisa de vinculação: Biomecânica aplica à Odontologia

As **quatorze** horas do dia **vinte e seis de novembro do ano de 2015** no Anfiteatro Bloco 4L Anexo A, sala 23 Campus Umuarama da Universidade Federal de Uberlândia, reuniu-se a Banca Examinadora, designada pelo Colegiado do Programa de Pós-graduação em maio de 2015, assim composta: Professores Doutores: João Carlos Gabrielli Biffi (UFU); Veridiana Resende Novais Simamoto (UFU); Robert Carvalho da Silva (UNICAMP); Mauro Pedrine Santamaria (UNESP); Paulo Vinícius Soares (UFU) orientador(a) do(a) candidato(a) **Analice Giovani Pereira.**

Iniciando os trabalhos o(a) presidente da mesa Dr. Paulo Vinícius Soares 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 argüição e resposta foram conforme as normas do Programa.

A seguir o senhor(a) presidente concedeu a palavra, pela ordem sucessivamente, aos(às) examinadore(a)(s), que passaram a argüir o(a) candidato(a). Ultimada a argüição, que se desenvolveu dentro dos termos regimentais, a Banca, em sessão secreta, atribuiu os conceitos finais.

Em face do resultado obtido, a Banca Examinadora considerou o(a) candidato(a) A provado(a).

Esta defesa de Tese de Doutorado é 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 às 17 horas e 00 minutos. Foi lavrada a presente ata que após lida e achada conforme foi assinada pela Banca Examinadora.

Prof. Dr. Robert Carvalho da Silva – UNICAMP

Prof. Dr. Mauro Pedrine Santamaria – UNESP

Prof. Dr. João Carlos Gabrielli Biffi – UFU

Profa. Dra. Veridiana Resende Novais Simamoto – UFU

Prof. Dr. Paulo Vinícius Soares – UFU
Orientador(a)

PPGO

DEDICATÓRIA

À Deus,

Dedico não apenas esta conquista, mas tudo que pude realizar na minha vida. Sem sua luz, orientação e benção nada seria possível.

À minha família

Meus pais, Marialice e Antônio, por representarem o melhor exemplo do bem, amor, companheirismo, cumplicidade, sinceridade, honestidade e dignidade que tenho a seguir.

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SUMÁRIO

RESUMO

A coexistência de recessões gengivais (RG) com indicação de recobrimento radicular e lesões cervicais não cariosas (LCNC) gera a necessidade de um protocolo que respeite e favoreça a saúde dos tecidos dentários e periodontais e permita tratamento com previsibilidade. Os objetivos principais desta tese foram: (1) verificar, por meio de avaliações clínicas, o comportamento do recobrimento de recessões gengivais sobreposto a restaurações diretas adesivas em resina composta e indiretas em cerâmica; (2) analisar a influência do nível de bateria do aparelho fotoativador nas características de resina composta; (3) analisar a influência dos materiais restauradores, resina composta, e cerâmica, na viabilidade de fibroblastos gengivais de cultura primária. Foram selecionados nove pacientes com boa higiene oral e estabilidade oclusal diagnosticados com LCNCs nos dentes anteriores incluindo pré-molares associadas a recessões gengivais (classe I e II de Miller) e apenas recessões gengivais. Após exame clínico inicial, ajuste oclusal foi realizado e os pacientes receberam um ou os dois tipos de tratamento, sendo restauração direta em resina composta da LCNC, polimento e tratamento da RG com recobrimento radicular Grupo RC (n=15); e restauração cerâmica indireta da LCNC's com recobrimento radicular Grupo C (n=15). As RG presentes em dentes superiores anteriores incluindo pré-molares que não apresentavam LCNCs clinicamente formadas foram tratadas com recobrimento radicular sendo este o grupo controle (n=15). Foram realizados testes de sorção e solubilidade, análise do grau de conversão e tração diametral, em amostras de resina composta (n=10) fotoativadas com LED a 100, 50 e 10% de carga da bateria. E a viabilidade de fibroblastos sobre discos de resina, cerâmica e dentina (n=3) foi analisada. Foi concluída a primeira etapa do acompanhamento clínico (90) dias. Os dados obtidos nas diferentes fases foram tabulados e submetidos à análise para detecção de distribuição normal e homogeneidade. Dentro dos limites deste estudo podemos concluir que: a carga da bateria do LED influencia as características do material restaurador; os materiais restauradores apresentam biocompatibilidade com fibroblastos gengivais; e a associação de tratamentos, cirúrgico e restaurador, apresenta

resultados satisfatórios, em dentes acometidos simultaneamente por LCNC e RG.

ABSTRACT

The coexistence of gingival recession (GR) with root coverage indication and non-carious cervical lesions (LCNC) generates the need for a protocol that respects and promotes health of dental and periodontal tissues and allows treatment predictability. The main objectives of this theses were: (1) verify, through clinical evaluations, the connective tissue graft for root coverage on direct and indirect restorations made of ceramic resin; (2) analyze the influence of the battery level of the LED curing unit in the composite resin characteristics; (3) assess the influence of restorative materials, composite resin and ceramics, on the viability of gingival fibroblasts from primary culture. Nine patients with good oral hygiene and occlusal stability diagnosed with LCNCs the anterior teeth including premolars associated with gingival recession (class I and II of Miller) and only gingival recession were selected. After initial clinical examination, occlusal adjustment was performed and the patients had their teeth randomized allocated on direct composite resin restoration of LCNC, polishing and GR treatment with connective tissue graft and advanced coronally flap CR group (n = 15); and indirect ceramic restoration of the LCNC's and GR treatment (CTG+CAF) Group C (n = 15). The GR presented teeth with no clinically formed LCNCs cavity were treated using (CTG+CAF) being the control group (n = 15). Sorption and solubility tests, analysis of the degree of conversion and diametral tensile strength were performed in composite resin samples (n = 10) photoactivated by 100, 50 and 10% battery charge LED unit. The viability of fibroblasts on composite resin, ceramics and dentin disks (n = 3) was examined. Clinical follow-up was performed for three months. The data obtained at different stages were tabulated and subjected to analysis for detection of normal distribution and homogeneity. The results showed that: the LED unit with 10% battery affects the characteristics of the composite resin; restorative materials present biocompatibility with gingival fibroblasts; and the association of surgical and restorative treatment of teeth affected by NCCL and GR presents successful results at 3-month follow-up.

1. INTRODUÇÃO E REFERENCIAL TEÓRICO

As lesões cervicais não cariosas (LCNCs) são desafios cada vez mais rotineiros na prática clínica odontológica (Smith et al.2008, Soares et al. 2013a, Soares et al. 2013b). Essas lesões são caracterizadas pelo desgaste de tecido dental mineralizado, na ausência de cárie, localizado na região cervical, principalmente em pré-molares superiores e inferiores (Smith et al. 2008, Wood et al. 2008). A etiologia das LCNCs é um complexo processo de interações de mecanismos, creditada aos fatores tensão (acúmulo de tração/compressão), fricção (atrição e abrasão) e biocorrosão (degradação causada por ácidos endógenos e exógenos) (Grippo et al. 2012).

Problemas periodontais associados a danos na estrutura dentária livres de contaminação bacteriana também têm sido rotineiramente tratados por profissionais na prática clínica na atualidade. A recessão gengival (RG), definida como posição apical em relação à junção cemento-esmalte da margem gengival que expõe a superfície radicular (Wennstrom, 1996), é uma patologia periodontal que acomete grande número de pessoas e possui vários fatores etiológicos. Dentre os principais fatores estão, inflamação de origem bacteriana, escovação traumática, deiscência óssea (trauma periodontal secundário), ação de freios e bridas, procedimentos restauradores e ortodônticos iatrogênicos (Efeoglu et al., 2012). Além do comprometimento estético quando localizada em dentes superiores anteriores, as RGs também favorecem ocorrência de hipersensibilidade dentinária por propiciar exposição dos túbulos dentinários ao meio bucal (Pini-Prato et al., 2010).

A exposição da superfície radicular pode acontecer concomitante a formação de LCNCs, pois ambas as situações podem surgir a partir da concentração de tensões (Romeed et al., 2012) na região da junção cemento-esmalte dos dentes, e consequentemente periodonto de sustentação, ao receberem carregamento oclusal cêntrico ou excêntrico exacerbado. Vários fatores podem contribuir para o desenvolvimento das LCNCs, e inicialmente, estas lesões foram comumente descritas e classificadas de acordo com sua etiologia primária em lesões de erosão, abrasão e abfração (Terry et al., 2003).

Atualmente, devemos considerar, devido à atuação simultânea dos fatores causais (atrição, tensão e biocorrosão), que os desgastes sem envolvimento bacteriano às estruturas dentárias na região cervical devam ser chamados de lesões cervicais não-cariosas (Grippo et al. 2012).

Apesar de tradicionalmente, a maioria dos profissionais tratar as LCNCs apenas com procedimentos restauradores convencionais, em grande parte dos casos o tratamento periodontal associado ao restaurador provê melhores resultados funcionais e estéticos (Alkan et al., 2006). Nos casos em que as LCNCs se apresentam em um estágio inicial, sem cavidade clinicamente identificável, e apenas um aplainamento radicular é necessário para descontaminação mecânica da superfície radicular exposta, é possível tratar a recessão gengival e a LCNC apenas com recobrimento radicular associado a enxerto de tecido conjuntivo (Soares et al. 2015). Entretanto, para tratamento das RGs acompanhadas de LCNCs com cavidade clinicamente formada, a restauração da lesão é indicada devido tanto à impossibilidade de realização do procedimento de aplainamento radicular (Deliberador et al., 2012) quanto a necessidade de restauração das estruturas mineralizadas perdidas (Machado et al. 2015). Portanto, a necessidade de se associar os tratamentos restaurador e cirúrgico torna-se fundamental para a reabilitação de dentes acometidos por LCNC associada a RG, localizados em áreas com comprometimento estético (Soares et al. 2015).

A cicatrização de enxertos de tecido conjuntivo que tem como parte do leito receptor materiais restauradores aplicados no tratamento de LCNCs, sejam eles cimentos ionoméricos modificados ou resinas compostas, é bem conhecida na literatura (Alkan et al., 2006). A formação de epitélio juncional longo foi histologicamente comprovada sobre os materiais restauradores ao observar-se redução na profundidade de sondagem e ausência de sinais de inflamação após o tratamento (Martins et al., 2007). Entretanto, um protocolo previsível para o tratamento multidisciplinar do conjunto RG/LCNC ainda não está totalmente definido.

Após o recobrimento radicular de dentes com LCNCs restauradas o material restaurador permanece encoberto pelo tecido gengival e deve, portanto, não influenciar negativamente a saúde do mesmo (Santamaria et al., 2011). Lisura superficial e polimento do material garantem melhor ambiente para cicatrização e reparo do tecido gengival, uma vez que facilidade de adesão da placa bacteriana é diretamente proporcional à rugosidade da superfície (Lindhe 2010). Quando bem confeccionadas, as restaurações mesmo que sub-gengivais parecem não interferir na microflora subgengival nem no comportamento inflamatório resultante de enxerto de tecido conjuntivo (Santamaria et al. 2012). Portanto o conhecimento do comportamento celular em diferentes superfícies de materiais restauradores é importante para garantir a previsibilidade do tratamento.

A análise e preservação do comportamento biomecânico saudável do conjunto dente/periodonto de sustentação/periodonto de proteção nas situações de RG/LCNC é de extrema importância, pois contatos prematuros podem causar distúrbios na correta dissipação das tensões no longo-eixo dos dentes e dos tecidos circundantes. Em situações em que há contato prematuro ou outra interferência oclusal, a concentração de tensões pode exceder os níveis de tolerância óssea, resultando em acúmulo de micro-danos na interface osso-raiz que podem induzir à reabsorção óssea (Zucchelli et al., 2006). A presença de reabsorção óssea fragiliza o tecido gengival que circunda o dente deixando-o susceptível à recessão. As interferências oclusais são, portanto, fator modificador da doença periodontal – recessão gengival (Lindhe, 2010).

Restaurações em resina composta são amplamente utilizadas na reabilitação de LCNCs por ser um material com carcteristicas biomecânicas (Soares et al., 2013), funcionais e estéticas satisfatórias (Namgung et al., 2013). Entretanto a previsibilidade e as propriedades do material restaurador dependem de sua utilização de modo apropriado. O preparo da estrutura dentária remanescente, a execução do sistema adesivo e a fotoativação adequados da resina composta resultam em restaurações funcionais, estéticas, biocompatíveis. Estas características são alcançadas devido ao alcance do melhor desempenho do material resultante do apropriado grau de conversão dos monômeros (Pereira et al. 2015).

Ao restaurar uma LCNC o material restaurador fica em íntimo contato com o tecido gengival adjacente, com a saliva e fluido gengival antes mesmo da finalização da polimerização, que pode durar certa de 10 minutos (Soares et al., 2013). Durante o processo de polimerização e mesmo após sua conclusão, monômeros livres permanecem presentes no material restaurador e podem se desprender sendo incorporado pelos fluidos orais (dos Santos et al., 2010). De acordo com Sideridou e Karabela (2011), os compósitos odontológicos em ambiente bucal podem absorver água e produtos químicos, tais como os encontrados na saliva ou nos alimentos (ácidos, bases, sais e álcoois), podendo liberar substâncias da sua composição.

A utilização de diversos materiais restauradores utilizados para o tratamento de LCNCs é amplamente estudada e constitui uma prática previsível. Restaurações em resina fluida (Perez 2010), cimento de ionômero de vidro modificado por resina (Santamaria et al. 2013) e resina composta híbridas e nanoíbridas (Soares et al 2013b) apresentam bons resultados quando utilizadas em LCNCs. Assim como as restaurações em cerâmica podem ser aplicadas ao tratamento de LCNCs com resultados satisfatórios devido à suas propriedades e características (Pereira et al. 2015). Entretanto, a escolha do material mais adequado para restaurar LCNCs ainda deve ser bastante discutida uma vez que não há consenso na literatura sobre qual seria o melhor protocolo de tratamento.

Portanto, o presente trabalho é justificado pela necessidade de avaliar o desempenho biomecânico de diferentes técnicas restauradoras para LCNC, além do comportamento do enxerto gengival na estabilização da recessão gengival quando o leito receptor é parcialmente formado por material restaurador. Justifica-se ainda pela necessidade de análise do material restaurador diante de diferentes situações de fotoativação, podendo influenciar seu grau de conversão, sorção e solubilidade de fuidos e resistência coesiva, além de avaliar a citotoxicidade que este representa para fibroblastos gengivais.

2. **CAPÍTULOS**

Capítulo 1

Does the battery level of a cordless LED unit influence the properties of a nanofilled composite resin?

Running Title: LED unit battery level influence on composite resin

Article Category: Laboratory research

Operative Dentistry

Analice Giovani Pereira, DDS, MSc, Luís Henrique Araújo Raposo, DDS, MSc, PhD, Daniela Navarro Ribeiro Teixeira, Ramon Corrêa de Queiroz Gonzaga, Igor Oliveiros Cardoso, Carlos José Soares, Paulo Vinícius Soares, DDS, MSc, PhD

CLINICAL RELEVANCE

Cordless light-curing LED units are widely used in dental practice. Clinicians must be careful on charging this equipment due to the possible influence of its battery voltage/light intensity on the properties of composite resin restorations.

SUMARY

The properties of composite resins can be influenced by light activation, depending primarily on the performance of the curing unit. The aim of this study was to evaluate the influence of different battery levels of a cordless LED unit on the properties of a nanofilled composite resin. First, the battery voltage and light intensity of the cordless LED unit were individually checked for all light-curing cycles. Then, composite resin discs were prepared and light-cured with different battery levels: HL- high level (100%); ML- medium level (50%); and LL-low level (10%). The degree of conversion, diametral tensile strength, sorption and solubility of the specimens were tested. Data were checked for homoscedasticity and submitted to one-way analysis of variance (ANOVA) followed by Tukey HSD and Pearson correlation tests ($p<0.05$). The battery voltage and light intensity varied significantly among the groups ($p<0.001$). LL group presented lower degree of conversion comparing to HL and ML groups ($p<0.001$), which shower similar results ($p=0.182$). Lower diametral tensile strength was also verified for LL group when compared to HL and ML groups ($p<0.001$), which presented no difference ($p=0.052$). Positive correlation was observed between the light intensity and the parameters studied, with exception for the sorption and solubility ($p<0.001$). ML and LL groups showed higher sorption when compared to HL group ($p<0.001$), not differing between them ($p=0.535$). No significant differences were found for solubility between ML and LL groups ($p=0.104$), but HL group presented lower values ($p<0.001$). The different battery levels of the cordless LED curing unit influenced all the properties of the nanofilled composite resin evaluated.

Key-words: Composite resin, Curing light, FTIR, Solubility, Sorption, Tensile strength.

INTRODUCTION

Since the early 1980’s, light-cured composite-based materials are routinely used for esthetic dental restorations, being widely used for anterior and posterior applications. The increased popularity of light-activated composites took place due to its suitable biocompatibility, mechanical properties and color stability.[1] Unfortunately, demands of these restorations with regard to in situ placement and curing still leave significant room for advancements, particularly with respect to polymerization shrinkage and polymerization-induced stress, thermal expansion mismatch, fracture, abrasion and wear resistance, marginal leakage, and toxicity.[1, 2]

One of the most important parameters involved in the light-curing of composite resins is the radiant exposure, calculated as the product of the irradiance and the time of irradiation provided by the light unit.[3] When more intense light energy is used to activate a composite resin, more photons are able to reach the photoinitiators within the resin, which are activated and raised to the excited state. In this state, the photoinitiator molecule collides with an amine, and a free radical is formed. Then, the latter reacts with the carbon to form a carbon double bond (C=C) of a monomer molecule, and thus polymerization is initiated.[4] Hence, more light energy will commonly result in higher degree of conversion of monomers into polymers.

In the clinical dental practice, light-curing units and their light output intensities can vary significantly, with pronounced differences for newer lights such as argon ion lasers and light-emitting diodes (LEDs), which are continuously improved, achieving higher irradiation intensities.[5, 6] A study which evaluated a series of commercial composite resins found that different energy doses were required to reach appropriate material properties for different irradiation intensities.[7] Additionally, it was also shown that the degree of conversion decreased with increased irradiation intensities for equivalent doses.[8] In other several studies, the results and correlations observed regarding reciprocity, varied depending on the type of material, the curing parameters used and the degree of conversion achieved during irradiation.[9, 10]

The longevity of composite resin restorations is also dependent upon its resistance to degradation in the oral environment.[11] Some properties of composites, such as sorption and solubility, are important parameters that allow predicting the behavior of composite restorations. Fluid sorption by composite resins is a diffusion-controlled process that may cause chemical degradation of the material, leading to several problems, such as filler-polymeric matrix debonding and residual monomer release by lixiviation.[12] This process can seriously decrease the mechanical properties of the composite materials, also reducing the longevity of composite resin restorations.

The solubility of composite resins is directly affected by the amount of leached unreacted monomers and filler particle loss.[13] The sorption and solubility of composite resins depend on the composition of each material, including filler content, size, shape, interparticle spacing, the monomer type, degree of conversion, and the efficiency of the filler-matrix bonding.[14] The degree of conversion of a resin composite is crucial in determining the mechanical performance of the material and its biocompatibility. The strength, elastic modulus, hardness and solubility of composite resins have also been shown to directly relate to the degree of conversion.[15]

Lithium-Ion battery is the most common power source used by the current cordless LED curing units available, and little is known about its influence on the performance of this class of equipment along discharging. Recently, a professional product review was released by the American Dental Association with some valuable data about several cordless LED units.[16] From that period, cordless LED curing lights have become increasingly employed in the recent dental practice and more studies are needed to clarify its working mechanisms and limitations.

Thus, the aim of this study was to evaluate the effect of different battery levels (100%, 50% and 10%) of a cordless LED unit on its battery voltage and light intensity, and its influence on the degree of conversion, diametral tensile strength, sorption and solubility of a nanofilled composite resin. The null-hypothesis tested in this study was that the different battery levels of the cordless LED unit would not influence the performance of the equipment and the properties of the composite resin evaluated.

MATERIALS AND METHODS

Battery voltage and light intensity measurements

In order to determine the power percentage corresponding to each battery level, three new similar cordless LED units (Coltolux, Coltente, Feldwiesenstrasse, Switzerland) were fully charged as recommended by the manufacturer, and used until complete unloading. The maximum number of cycles possible to be completed with the full-charged batteries (100%) was found (150 cycles of 60 seconds) and, based on it, proportion was made to define the number of cycles corresponding to 50% and 10% battery levels. The battery voltage (V) and light intensity (mW/cm^2) of the cordless LED units were individually checked for all light cycles reached by the equipment. For this, a voltage tester and a luxmeter probe (PHYWE Systems, Gottingen, Germany) were connected to a digital multimeter unit (HGL 2000N, PCE, Tobarra, Spain) in order to make the measurements before and during each light cycle for battery voltage and light intensity, respectively. The data for the two measurements were tabulated and recorded. Since no significant differences were observed on the performance of the three cordless LED units for the different battery levels evaluated ($p>0.05$), it was defined to use a single unit to carry out the next experimental steps. The battery voltage (V) and light intensity (mW/cm^2) verified along the complete discharging (150 cycles of 60 seconds) of the selected cordless LED unit were recorded and plotted (Fig. 1).

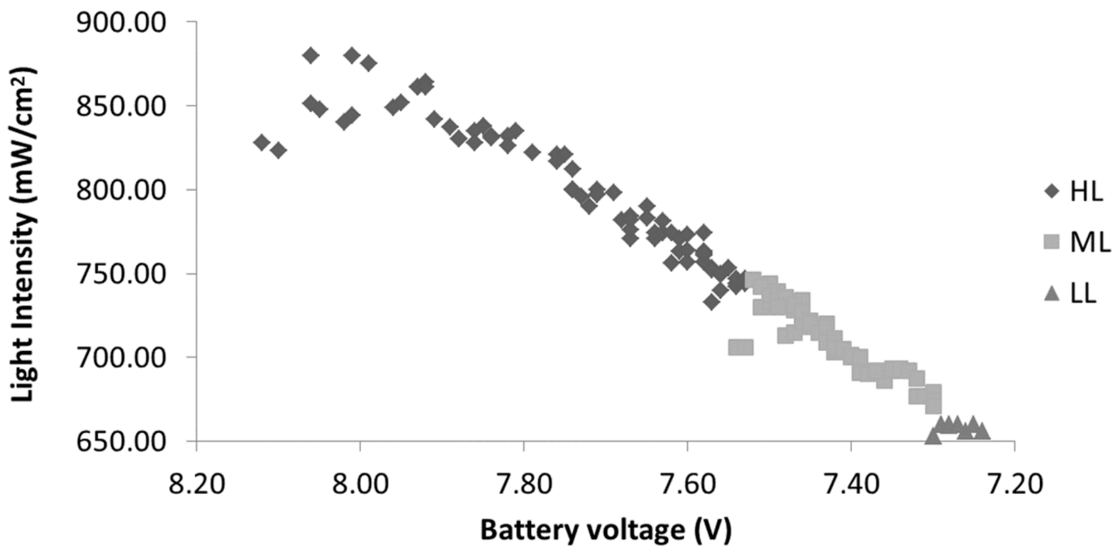


Figure 1: Graph plotting of the battery voltage (V) and light intensity (mW/cm2) observed for the cordless LED curing-light unit along the complete discharging (150 cycles of 60 seconds).

Specimen preparation

Nanofilled composite resin specimens (Filtek Supreme XT, shade A2B, 3M-ESPE, St. Paul, MN, USA) were prepared in a stainless steel matrix (5 mm in diameter × 2 mm in height), for all tests. Discs were light-cured through a Mylar strip for 20 seconds using the cordless LED unit with different battery levels according to the experimental groups: HL- high battery level (100%); ML- medium battery level (50%); and LL- low battery level (10%).

Degree of conversion

The degree of conversion (DC) of the composite resin specimens (n=10) was accessed in a Fourier-Transformed Infrared Spectroscopy (FT-IR) unit (Tensor 27, Bruker, Germany). The number of remaining carbon double bonds was determined. The remaining unconverted carbon double bonds were calculated by comparing the percentage of aliphatic C=C (vinyl) (1638 cm^{-1}) and aromatic C=C absorption (1608 cm^{-1}) between cured and uncured specimens. The spectra of the cured and uncured specimens were obtained using 128 scans at a resolution of 4 cm^{-1}, within the range from 1000 to 6000 cm^{-1}. The spectra were subtracted of the background spectra out using FTIR unit provided software (OMNIC 6.1, Nicolet Instrument Corp, Madison, WI, USA). The acquired spectra were expanded and analyzed in the region of interest from 1560 to 1670 cm^{-1}. The DC was calculated by standard baseline technique using the comparison of peak area at 1639 cm^{-1} (aliphatic C=C) and internal standard peak at 1609 cm^{-1} (aromatic C=C). Then, the DC was calculated by the following equation:

$$DC(\%) = [1 - \frac{Cured\ aliphatic/aromatic\ ratio}{Uncured\ aliphatic/aromatic\ ratio}] \times 100$$

Diametral tensile strength

Diametral tensile strength test was performed in the specimens previously used for obtaining degree of conversion (n=10), using a mechanical testing machine (DL 2000, EMIC, São José dos Pinhais, PR, Brazil). Specimens were positioned vertically on the testing machine, between the stainless steel flat tip and base and a compressive load was applied vertically on the lateral portion of the cylinder, at a crosshead speed of 0.5 mm/min, producing tensile stresses perpendicular to the vertical plane passing through the center of the specimen until failure. After each compressive test, the fracture load *(F*), in Newtons (N), was recorded and the diametral tensile strength (σ_t) was calculated (MPa) as follows:

$$\sigma_t = 2F/\pi dh$$

where, *d* is the diameter (5 mm), and *h* the height (2 mm) of specimens, and the constant *π*, 3.1416.

Sorption and Solubility

The sorption (Sor) and solubility (Sol) of the composite resin was verified for each experimental group in new specimens (n=10). After preparation, the specimens were stored in a desiccator with silica gel and maintained in an oven at 37°C for 24 hours. After this period, the specimens were weighted on an analytical balance with 0.01 mg accuracy, (AG200, Gehaka, São Paulo, SP, Brazil), at 24 hours intervals until a constant weight was obtained, which was considered *m1*. Then, the specimens were individually placed in plastic vials containing 10 ml of artificial saliva and stored at 37°C. The specimens were weighted at intervals of 1, 24, 48 and 72 hours to progressively scanning sorption. Following the weighting procedures, the specimens were newly immersed in the media storage and kept at 37°C oven. After 7 days, the specimens were removed from storage, the excess of liquid was dried with absorbent papers, and specimens were weighted for obtaining *m2*. Then, the specimens were taken to the desiccator with silica gel at 37ºC to eliminate the absorbed saliva, being weighted daily until reaching constant mass, considered *m3*.

The major and minor diameters and thickness of the specimens were measured at four points using digital caliper (CD6 CS, Mitutoyo, Kanagawa, Japan), after final drying in *m1*. These measures were used to obtain the volume (*V*) of each sample in mm^3 and to calculate the sorption (SOR) and solubility (SOL) rates, according to the following:

$$Sor = \frac{m2 - m3}{V} \qquad\qquad Sol = \frac{m1 - m3}{V}$$

where, *m*1 is the mass of the specimen (µg) before the immersion in liquid medium, *m2* is the mass of the specimen (µg) after the immersion in liquid medium over 7 days, *m3* is the mass of the specimen (µg) after desiccation until reaching constant mass and *V* the volume (mm^3).[17]

Statistical analysis

Data for all tests were checked for homoscedasticity and submitted to one-way analysis of variance (ANOVA) followed by Tukey HSD test. Correlations between the light intensity and the battery voltage, degree of conversion, diametral tensile strength, sorption and solubility were checked by Pearson correlation test. All tests were conducted at 95% significance level using statistical package (SigmaPlot 12.0, Systat Software, San Jose, CA, USA).

RESULTS

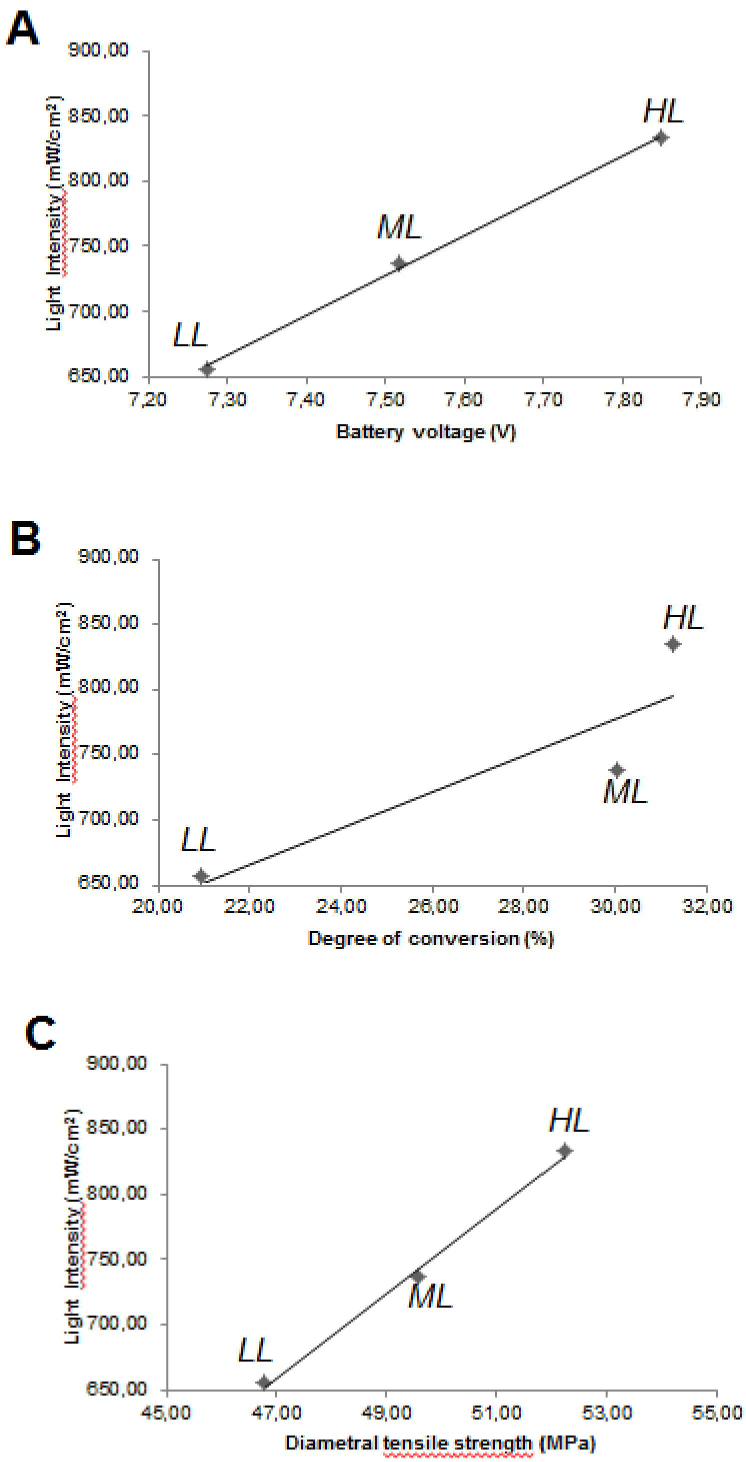
The results for degree of conversion (DC), diametral tensile strength (σ_t), sorption and solubility are shown in Table 1. Lower DC was observed for the LL group comparing to HL and ML groups ($p<0.001$), which shower similar results ($p=0.182$). Lower σ_t was also verified for LL group when compared to HL ($p<0.001$) and ML ($p=0.035$) groups, which had no difference between them ($p=0.052$). Higher sorption was detected for ML ($p=0.012$) and LL ($p<0.001$) groups when compared to HL, but these groups were similar ($p=0.535$). Lower solubility was observed for HL group than for ML ($p<0.001$) and LL ($p<0.001$) groups, which showed no significant differences ($p=0.104$). Positive correlation was observed between the light intensity and the following factors: battery level (99%), degree of conversion (86%), and diametral strength (70%); while negative correlation was detected between light intensity and sorption (-63%) and solubility (-83%) ($p<0.001$). The correlation results for the different factor association are plotted in Figure 2.

Table 1

Groups	**Battery voltage (V)**	**Light intensity (mW/cm^2)**	**Degree of conversion (%)**	***Diametral tensile strength* (MPa)**	**Sorption (µg/mm^3)**	**Solubility (µg/mm^3)**
HL (100%)	7.8 ± 0.02^A	831.7 ± 3.6^A	31.3 ± 2.1^A	52.2 ± 1.5^A	16.1 ± 6.2^A	-10.6 ± 5.3^A
ML (50%)	7.5 ± 0.01^B	737.8 ± 5.0^B	30.1 ± 1.0^A	49.6 ± 2.1^A	26.5 ± 3.9^B	7.2 ± 5.0^B
LL (10%)	7.3 ± 0.02^C	656.2 ± 5.3^C	20.9 ± 1.2^B	46.8 ± 3.2^B	30.2 ± 10.8^B	13.3 ± 8.4^B

Table 1 – Means and standard deviation (±) for the tests performed according to the battery level (%) of the groups.

Figure 2


A
900,00
850,00
800,00
750,00
700,00
650,00
Light Intensity (mW/cm²)
HL
ML
LL
7,20
7,30
7,40
7,50
7,60
7,70
7,80
7,90
Battery voltage (V)
B
900,00
850,00
800,00
750,00
700,00
650,00
Light Intensity (mW/cm²)
HL
ML
LL
20,00
22,00
24,00
26,00
28,00
30,00
32,00
Degree of conversion (%)
C
900,00
850,00
800,00
750,00
700,00
650,00
Light Intensity (mW/cm²)
HL
ML
LL
45,00
47,00
49,00
51,00
53,00
55,00
Diametral tensile strength (MPa)

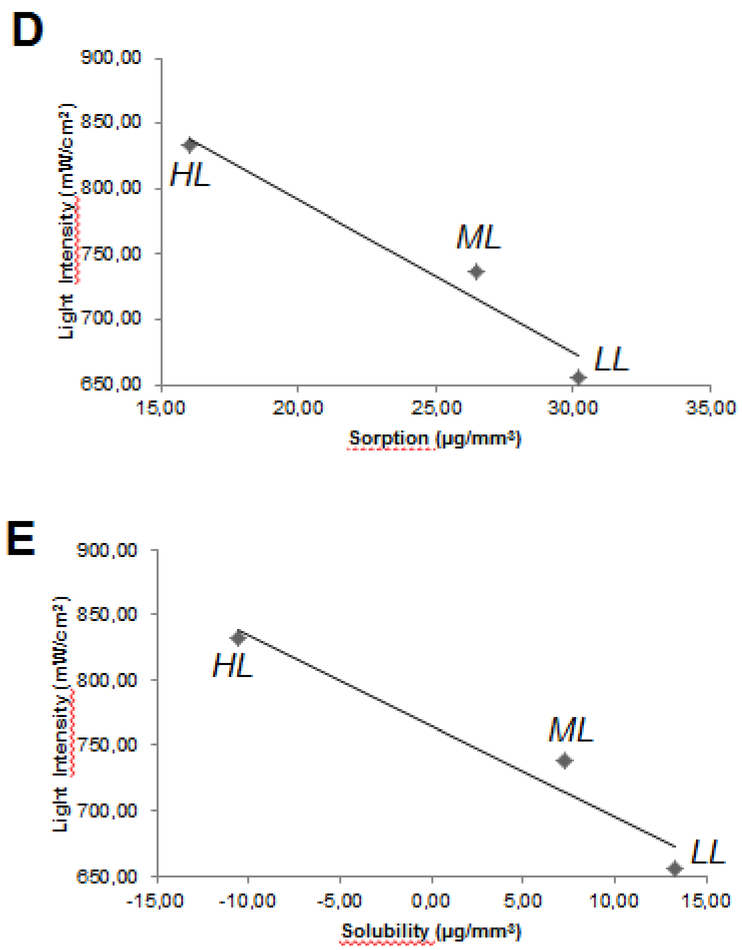


Figure 2: Graph plotting of the correlation results between the light intensity (mW/cm^2) and the different factors tested: A- Battery voltage (V); B- Degree of conversion (%); C- Diametral tensile strength (MPa); D- Sorption (µg/mm^3); E- Solubility (µg/mm^3); *HL- high battery level; ML- medium battery level; LL- low battery level.

DISCUSSION

The null-hypothesis was rejected, since the battery level of the cordless LED unit affected the battery voltage and the light intensity of the equipment, besides the degree of conversion (DC), diametral tensile strength (σ_t), sorption and solubility of the nanofilled composite resin evaluated.

In light-cured materials, the DC is determined by the product of irradiation of light and exposure time.[18] The conversion of monomers is proportional to the square root of the light intensity applied to the composite,[19] and according to our results, the light intensity of a cordless LED unit can be influenced by battery voltage, affecting the degree of conversion, diametral tensile strength, sorption and solubility of composite resins. Thus, one may assume that the light intensity of the cordless LED units is also dependent upon the battery level.

No studies have reported the association between the battery level of cordless LED units and the changes in the properties of light-cured restorative materials. However, the relationship between the DC and mechanical properties of composites have been shown.[20] As seen, low battery levels affects the battery voltage and consequently influence the light intensity of cordless LED units, also changing some properties of composite resins. Currently, composite resin restorations are widely used in restorative dentistry, both in anterior and posterior applications.[21] These restorations are constantly under stresses resulting from masticatory function. From this point of view, besides selecting composite resins with suitable properties, clinicians must be careful on checking for appropriate charging of cordless light-curing units, since this is a decisive step to assure adequate performance to light-cured polymeric restorations.

The development of stresses in dental composite restorations depends on the material composition, including type of monomer, amount and type of inorganic filler, interactions between filler and matrix, polymerization parameters such as degree of conversion and rate of polymerization, besides material positioning and light-curing technique.[22, 23] Adequate polymerization is a critical factor for obtaining acceptable physical and mechanical performance from dental composites.[22, 24] During the curing process, the light passing through the composite is absorbed by the resin and dispersed by the filler content.[25] The light intensity and its effectiveness of cure is reduced in deeper increments, mainly above 2.0 mm.[26] The reduction on the battery level of cordless LED unit can also affect the degree of conversion of composites, since it results in reduced battery voltage/light intensity, producing less resistant dental restorations as shown by diametral tensile strength test.

The present study was initially conducted using three LED units from a single manufacturer and after verifying homogeneity among the equipment, one unit was selected for specimen preparation according to the experimental conditions. Although the LED curing light units commercially available present similar energy source provided by a Lithium-Ion battery,[16] differences among the performance of products from different manufacturers can be observed. Thus the results presented by this study cannot be directly considered for all other cordless LED equipment.

In the oral cavity, composite resin restorations are continuously exposed to chemical agents present in saliva, food and drinks that can contribute to degradation of the organic matrix.[27] There are several factors influencing the absorption of oral fluids by composites, for example, hydrophilicity of the polymer matrix, density of the composite filler material, porosity and solvents.[17] The water molecules can induce degradation of composites by two mechanisms. First, molecules diffuse into the polymer network and fill the free volume between the microvoids, causing plastification and swelling of the polymer, also initiating the breakup of chains with elution of the monomers.[17, 27] These molecules also tend to deteriorate the siloxane bonds, through a hydrolysis reaction, causing detachment of filler particles.[27, 28] Although a 50% reduction on the battery level was not able to significantly affect the degree of conversion and diametral strength of the composite evaluated, it has affected the sorption and solubility properties of the restorative material evaluated in this study. This finding can be critical for the longevity of composite restorations. Negative solubility values were observed for the HL specimens because the *m3* (mass after desiccation) was higher than the *m1* (mass before immersion). A possible explanation for these findings is that the fluid absorbed during storage was probably confined and included as part of the polymeric structure of the composite material.[13]

As observed, the capacity of composites to absorb fluids from oral environment and solubilize losing components can be influenced by the battery level of cordless LED curing units. This is probably due to the reduced light intensity reaching the composite resin during polymerization. These events lead to degradation and softening of the composites, mainly in the presence of acids, which may reduce some physical and mechanical properties such as hardness, strength and modulus of elasticity, besides favoring increased surface roughening.[29] These effects can be even more pronounced since several factors related to the chemical structure of polymer networks also determine the extension in which the material is affected by the aqueous medium surrounding it.[30] Important features include chemical hydrophilicity of the polymer and differences in solubility between the polymer and the solvent.[31] Structural parameters include the density and porosity of the polymeric network.[22, 23, 25] The properties related to the inorganic particles of the material are also significant.[26] Moreover, the increased levels of sorption and solubility on composite resins can lead to damages on soft tissues adjacent to these restorations since they become more susceptible to plaque accumulation.[32]

The parameters observed in this study support an inverse relationship between the battery voltage/light intensity and sorption/solubility, while a proportional behavior was detected to the battery voltage/light intensity, degree of conversion and diametral strength decrease. This study used laboratory conditions for light-curing, in which no distance remained between the tip of the light source and the restorative material. Considering our findings, this picture can be worsened in clinical situations, when the distance between the light source and the polymeric restorative material is increased by limiting factors, such as in the restoration of deep cavities, fiber post luting, or when indirect restorations are interposed.

Therefore, clinicians must be careful when using light-curing with cordless LED units powered by battery sources, because once battery is running out of charge, battery voltage and light intensity are affected, resulting in decreased properties for composite resin restorations. Despite the intrinsic limitations of the present study, such as the *in vitro* design and the analysis of a single cordless LED unit and composite resin material, our results help to clarify the influence of the battery level (battery voltage/light intensity) of these curing units on the properties of composite restorations. Further studies taking into consideration additional laboratory tests and clinical outcomes with different cordless LED units and other resin-based materials such as composites, adhesives systems and resin cements would be beneficial.

CONCLUSIONS

Within the limitations of the present study it was concluded that the different battery level of a cordless LED unit affected its battery voltage/light intensity, consequently influencing the degree of conversion, diametral tensile strength, sorption and solubility of a nanofilled composite resin.

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Capítulo 2

Assessment of primary gingival fibroblasts viability on different substrates

Journal of Periodontal Research

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Abstract

Background and Objective: The high prevalence of non-carious cervical lesions (NCCLs) associated with gingival recessions makes important to assess the performance of associated treatment approaches for these conditions. Restorative and surgical periodontal procedures are frequently combined for the NCCLs treatment, establishing close relationship between the restorative material and covering connective tissue. Thus, the aim of this study was to assess the influence of different materials used for restoring NCCLs on the viability of primary gingival fibroblasts.

Material and Methods: Dentin discs (n=10) obtained from the root surface of extracted teeth, and nanofilled composite resin and ceramic discs (n=10) were prepared. Cells were obtained from three samples of connective tissue graft from patients of a randomized controlled trial. The tissue was prepared and the fibroblasts cultivated on the discs from the different substrates during 24, 48 and 72 h periods. Non-cured composite resin substrate was used as negative control and cells in culture medium without substrate as positive control. The cell viability was measured by the reduction of MTT formazan crystals by live cells. Data were analyzed at two-way analysis of variance and Bonferroni post hoc test using GraphPad Prism software ($p<.05$).

Results: The 24h analysis for cell viability was found over 70% for all patients in all substrates tested, with significant differences between dentin and ceramic substrates for patients B and C ($p<.05$ and $p<.01$, respectively). In the 48 h analysis, there was no difference between the substrates tested for all patients ($p>.05$). In the 72 h analysis, only patient A presented significant differences for the dentin and ceramic substrates ($p<.05$).

Conclusions: The substrates tested have not adversely affected cell viability at 24 h analysis and dentin was the most favorable substrate for this period. Lithium disilicate ceramic presented the better results for 72 h analysis, performing as a good restorative material for the treatment of NCCLs associated to GR with root coverage indication.

Key words: cell viability, MTT, primary gingival fibroblasts, restorative materials.

Introduction

Gingival recession is defined as soft and hard tissue displacement resulting in root surface exposure (1), and it may be due to several etiologic factors, including periodontal disease, destructive mechanical forces, iatrogenic factors such as uncontrolled orthodontic movements and improper restorations, viral infections of the gingiva, anatomical factors like tooth malpositioning and frenum pull (2). Recession of marginal gingival tissues commonly results in dental hypersensitivity, esthetic complaints, and a tendency toward root caries (3).

The absence of proper gingival protection at the cervical region and the cumulative effect of inadequate oral hygiene in conjunction to non-bacterial acid action, may favor loss of tooth mineralized structures at this area over time, causing the manifestation of non-carious cervical lesions (NCCLs) (4).The cementoenamel junction is invisible in 50% of gingival recessions because of cervical abrasions, meaning that NCCLs are already installed (5, 6). Despite this close association between gingival recession and NCCLs, direct restorative procedures such as with composite restorations are frequently selected as single treatment for this condition. However, optimal functional and esthetic results may require the combined use of restorative and surgical procedures (7).

It is generally confirmed that Miller Class I and II gingival recessions without interproximal structure loss, can be predictably treated using surgical techniques as coronally flaps, free gingival grafts and subepithelial connective tissue grafts (8). However, the connective tissue graft associated to coronally advanced flap (CTG+CAF) is considered the gold standard due to its high predictability for root coverage (9, 10).

Some studies reported that subgingival restorations can be harmful to the gingival health and recommend that the restorative material should be removed before root coverage procedures (11, 12). However, it is accepted that some restorative materials such as resin-modified glass ionomer (13) and composite resin (14, 15) may not interfere with the percentage of soft tissue coverage. It was shown that when a CTG is performed for the treatment of Miller Class I gingival recessions associated with a composite restoration for the treatment of NCCLs, the results are predictable if optimal plaque control, properly contoured and finished restorations and longitudinal observation of the patient are performed (13-15). Thus, no inflammatory signs will be present by periodontal soft tissue after treatment and long epithelium junctional attachment can be clinically (13) and histologically (16) observed on the gingival tissue around the restoration.

The association of both restorative and surgical treatments usually leads to the placement of a subgingival restoration. Combined approach may be considered as a treatment option for the NCCL associated to gingival recession since a recent study showed that the presence of subgingival restoration may not interfere with the local microflora and with GCF inflammatory markers analyzed (17). The combined approach is also taken when the depth of the cervical lesions does not allow adequate root planning (14) and the absence of restoration may affect the biomechanical behavior of the tooth (18).

The close contact between restored NCCLs and connective tissue grafts after gingival recession treatment represents a common situation when the combined treatment is performed. However, there is lack of laboratorial studies about the microbiological, immunological and histological effects of this restorative approach. Thus, the hypothesis of the present study was that primary gingival fibroblasts would maintain viability for a predetermined period over different substrates.

Material and Methods

Disc preparation

Dentin discs (N=10) were obtained from the root surface of extracted molar teeth (gathered following informed consent approved by the Committee for Ethics in Research of the Federal University of Uberlandia nº 379.492). The discs were prepared from root slices using diamond discs and burs until assuming approximately 5 mm diameter and 1 mm height. Then, the dentin discs were treated using a 400 mg tetracycline and 0.9% saline solution paste for three minutes, following rinsing with abundant saline solution for another three minutes.

Lithium dissilicate glass ceramic (e.max Press, shade HTA2, Ivoclar Vivadent, Schaan, Liechtenstein) discs (n=10), 5 mm in diameter and 1 mm thick, were pressed from self-curing acrylic resin (Duralay, Dental Reliance Mfg. Co., Alsip, IL, USA) patterns and glazed following the same laboratory protocol used for producing monolithic all ceramic restorations (18).

Nanofilled composite resin discs (Filtek Supreme XT, shade A2B, 3M-ESPE, St. Paul, MN, USA) were prepared in a stainless steel matrix 5 mm in diameter and 1 mm height (n=10). Discs were light-cured through a Mylar strip for 20 seconds using a cordless LED unit (Coltolux, Coltente, Feldwiesenstrasse, Switzerland) with 900 mW/cm^2 light output, and finishing was performed with aluminum oxide discs (Sof-Lex, 3M-ESPE).

Cell culture

Cells were obtained from samples of connective tissue graft from three patients participating of a parallel Randomized Control Trial who underwent periodontal surgery for root coverage using coronally advanced flap associated with connective tissue graft after restorative treatment for NCCLs. The RCT study was approved by the Committee for Ethics in Research of the Federal University of Uberlandia (protocol 379.492) and informed consent was obtained from all the subjects included in the study.

During the surgical procedure a small gingival biopsy consisting of connective tissue (4 mm length, 1 mm thickness) was harvested from the palate in the bicuspid region. The graft was placed in nutritional medium and immediately transported to the cell-culture laboratory. The graft was washed with 1X PBS buffer to remove fat and blood cells. Using sharp dissection, the graft was minced into 1-3 mm^3 chunks and the minced tissue was transferred to 15 mL conical tubes containing 3 mL of trypsin/EDTA (Cultilab, Brasil). The trypsin digestions occurred at 37ºC by 1 hour. The tissue was then filtered to a new conical tube, centrifuged at 1500 rpm for five minutes and re-suspended in 1 mL of RPMI-1640 medium (Sigma Aldrich, Saint Louis, MO, USA), supplemented with 10% fetal bovine serum (FBS), 1% gentamicin. The cells were transferred to a culture flask until they reached the desired confluence.

MTT assay

Discs of dentin, lithium dissilicate glass ceramic and nanofilled composite resin were placed at the bottom of wells, and the cells were cultivated over the substrates. Non-cured composite resin substrate was used as negative control and cells in culture medium without substrate as positive control. The cell viability was measured by the reduction of MTT formazan crystals by live cells. 2 x 10^4 cells/well were seeded in 96- well culture plates (Sarstedt, USA) and cultured for 24, 48 and 72 h periods in RPMI-1640 medium supplemented with 10% FBS, at 37ºC and 5% CO_2. Subsequently, MTT (Sigma Aldrich, Saint Louis, MO, USA) was added to a final concentration of 10% in each well and the cells were incubated for 4 h. Then SDS_dimetilformamide was added to stop the reaction and solubilize the formazan crystals. The microplate was protected from light and incubated overnight at 37 ºC. The read was done in a Multiskan™ FC Microplate Photometer (Thermo Scientific) at a wavelength of 570 nm. The cell viability was measured considering the relative absorbance of the samples.

Statistical Analyses

All data were analyzed using GraphPad Prism 5.0 software. Significant differences were determined using two-way analysis of variance (2-way ANOVA) and Bonferroni post hoc test. Statistical significance was considered when $p<0.05$.

Results

The 24h analysis for cell viability was found over 70% for all patients in all substrates tested, with significant differences between dentin and ceramic substrates for patients B and C ($p<.05$ and $p<.01$, respectively), presented in Fig. 1. In the 48 h analysis (Fig. 2), there was no difference between the substrates tested for all patients ($p>.05$). In the 72 h analysis (Fig. 3), only patient A presented significant differences for the dentin and ceramic substrates ($p<.05$). Positive control presented high cell viability in all period of analysis ($p<.05$); whereas the negative control showed none viable cells in any period ($p<.05$) (Figs. 1-3).

Discussion

The hypothesis of this study was accepted, since primary gingival fibroblasts remained viable after cultivated over different substrates for a predetermined period of 24 h. This result may be owned to the absence of cytotoxicity of the tested substrates, including the composite resin and glass ceramic restorative materials. Significant differences between dentin and ceramic substrates were observed at the first 24 h analysis for two patients when dentin presented a better environment for keeping the cells viability. The positive and negative controls showed results as it would be expected, since good cell viability was observed for the culture medium only and high cytotoxicity was verified for the non-cured composite resin in all periods of analysis.

After the first period, the viability of cells was reduced. At the 48 h analysis, the cells plated at both restorative materials and dentin substrates showed similar viability levels. The behavior of fibroblasts changed in the of 72 h analysis period, when cells cultivated on ceramic discs presented higher survival rates (viability) than those cultured on composite resin and dentin substrates. The high quality of surface smoothness and integrity presented by ceramic restorations (19) may have allowed higher cell viability, even when compared to dentin.

Dentin discs were chemically treated using tetracycline with saline solution paste. There is no consensus on literature about the best decontamination method for dentin surfaces, and according to the findings of this study the remaining tetracycline retained in the irregularities of the dentin discs may be cytotoxic. Chemical root-surface conditioning using a variety of agents, such as citric and phosphoric acids (20), ethylenediaminetetraacetic acid (21), and tetracycline hydrochloride (22), has been presented in order to detoxify, decontaminate and demineralize the root surface, thereby removing the smear layer and exposing the collagenous matrix of dentin and cementum (23, 24). However, the clinical relevance of root conditioning with an acid agent in routine periodontal surgery is still uncertain and there is no evidence that these products improve survival of connective tissue grafts (25, 26).

The present study used dentin discs obtained from teeth collected and stored for a long period. Also, the teeth used were not from the same patients whose the connective tissue grafts were obtained for fibroblast cell culture. This not autologous situation, associated to the potential cytotoxicity of tetracycline that can remain attached to dentin surface even after cleanness with saline solution (27), may have influenced the results of the present study.

Composite resin and ceramics can be used for the treatment of NCCLs on the restoration of dentin and enamel, respectively. The use of these materials for restoring NCCLs can result in a satisfactory treatment approach, able to mimic tooth structure as similar to natural as possible (28, 29). The properties presented by the both materials enables the restoration of not only the rigid structures lost, but also allows recovering of the biomechanical behavior of teeth during function (30). Besides, ceramic veneers ensure greater preservation of tooth structure, maintain tooth vitality, and produce adequate functional and esthetic results, presenting failure rates of only 0% to 5% over 1 to 5 years, which shows its predictability and inert characteristics (29).

As seen, in the restoration of NCCLs, the materials are placed in close relationship to the gingival sulcus and when root coverage procedures are performed, they become part of the graft receptor bed, so the relevance of assessing their influence on the viability of fibroblast cells. The biocompatibility of these restorative materials favors the healing of connective tissue grafts due to their satisfactory smoothness and refined surface, resulting in higher adherence of the junctional epithelium on root surfaces and restorations applied subgingivally. These factors may avoid gingival inflammation and favor the healing of connective tissue grafts, which is one of the main goals of the treatment for NCCLs (31, 32).

Clinical studies must be conducted in order to clarify the behavior of gingival cells concerning the restorative materials used for subgingival restorations in NCCLs. Within the limitations of this laboratory study, it can be concluded that the substrates tested have not adversely affected cell viability after 24 h and dentin was the most favorable substrate in this period. Lithium disilicate glass ceramic presented the better results for 72 h period, performing as a good restorative material for the treatment of NCCLs associated to GR with root coverage indication.

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Figures and Legends

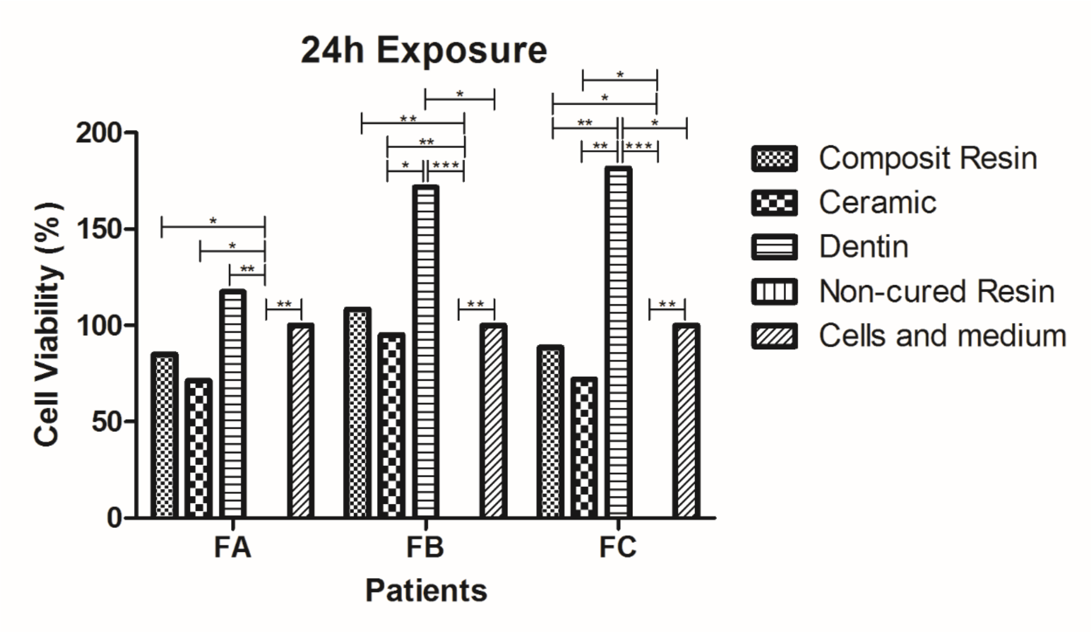

Figure 1 - After 24 hours exposure the gingival fibroblasts presented over 70% viability. Significant difference was observed between dentin and ceramic for patient B (p <.05) and an increased difference could be seen for patient C (p <.01). For the both patients the cells viability presented on dentin sample were higher than in negative control (p < .05).

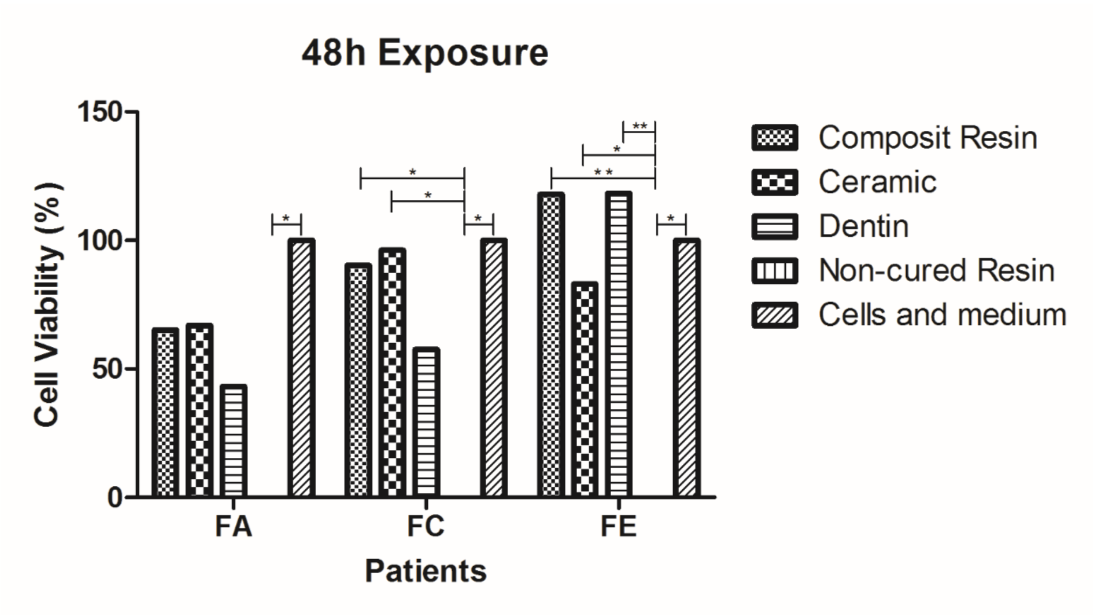

Figure 2 - The tested materials did not present difference in 48h analyses (p > .05). For patient A the results were different from the other two since the materials tested presented no difference even from positive control.

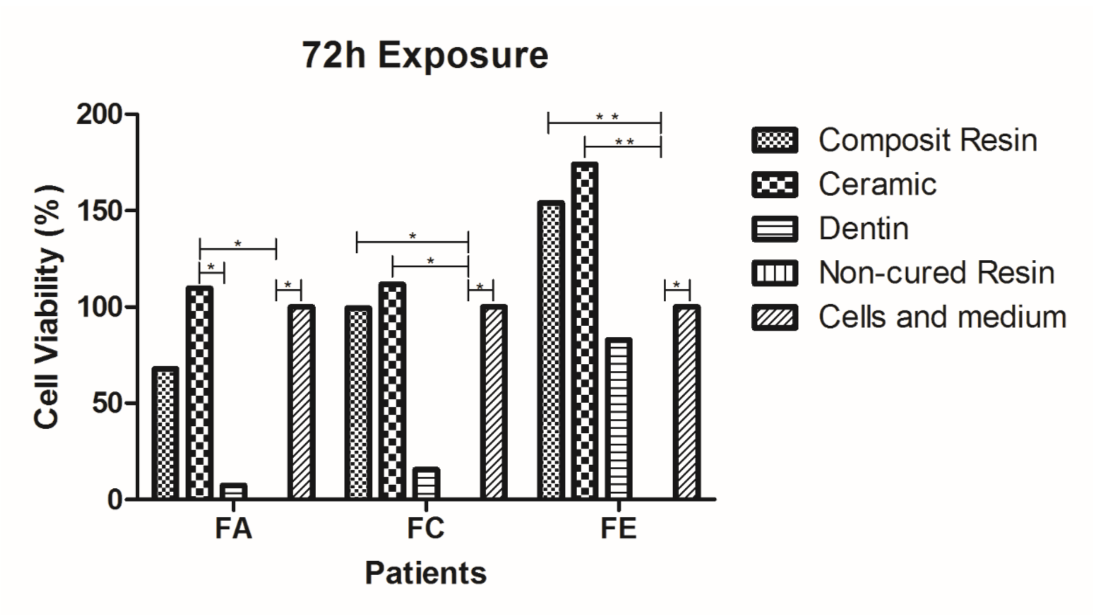

Figure 3 - Restorative materials presented no significant difference accept for patient A for which ceramic have shown better results than dentin regarding preserving fibroblasts viability (p < .05).

Capítulo 3

Periodontal and restorative treatment of gingival recession associated with non-carious cervical lesions: Case study

Journal of the International Academy of Periodontology

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Abstract

The association between gingival recession and non-carious cervical lesions is a common finding in Dentistry. These diseases have multifactorial etiology and the treatment should be multidisciplinary. Although traditionally the majority of professionals treat non-carious cervical lesions with conventional restorative procedures only, in most cases the association of periodontal and restorative treatments provides the best functional and aesthetic results. Thus, the objective of this case report was to present a new option of treatment, which consists on subepithelial connective tissue graft associated with coronally advanced flap technique upon dentin and non-carious cervical lesions restored with lithium dissilicate partial veneer. The patient whom complained about esthetic aspects of his teeth and cervical dentin hypersensitivity was submitted to occlusal adjustments and daily diet analysis in order to manage etiologic factors. Then, experienced operators performed restorative and surgical treatments. Periodontal clinical attachment level (probing depth + gingival margin), bleeding on probing and plaque index and integrity of the restorations were observed. During the monitoring period, the treatment was effective, with functional and esthetic results. The hypersensitivity disappeared and neither inflammatory characteristics in gingival tissue nor failures in restorations were noticed. It can be concluded that the treatment with associated techniques can be effective and predictable for patients with gingival recession and non-carious cervical lesions requiring or not restorative procedures under controlled conditions.

Key words: Connective tissue graft, lithium dissilicate, non-carious cervical lesions, root coverage, gingival recession.

Introduction

Gingival recession (GR) has been defined as the displacement of the soft tissue marginal apical to the cementoenamel junction (CEJ, Glossary of Periodontology Terms, AAP, 2001). This condition is frequently located at the buccal surface of teeth in patients with high standards of oral hygiene and can affect patients' life quality during smiling or function (Bherwani et al., 2014).

The exposure of root surfaces resulting from gingival recessions may be due to several etiologic factors, including periodontal disease, mechanical forces such as faulty tooth brushing, iatrogenic factors like uncontrolled orthodontic movement and improper restorations, viral infections and anatomical factors such as tooth malposition and frenum pull (Pradeep and Sharma, 2006). Marginal tissue recession results in dental hypersensitivity, esthetic complaints, and a tendency toward root caries (Alkan et al., 2006).

Many studies confirmed that Miller Class I and II gingival recessions, without interproximal structure loss, can be predictably treated and recovered with gingival tissue using surgical techniques as coronally flaps, free gingival grafts and subepithelial connective tissue grafts. However, the connective tissue graft is considered the gold-standard for its high predictability for root coverage (Cordioli et al., 2001; Bherwani et al., 2014).

The incidence of non-carious cervical lesions (NCCLs) has shown a continuous increase over the years (Borcic et al., 2006). The progressive nature of these lesions requires an early correction in order to prevent biological and biomechanical complications. The etiology is multi-factorial: a combination of stress (abfraction), friction (wear) and biocorrosion (chemical, biochemical and electrochemical degradation) (Grippo et al., 2012 ; Soares et al., 2013; 2014). Thus, a multidisciplinary approach to deal with this condition has been proposed in order to optimize the final esthetic outcome. Periodontal surgery is majority associated with restorative therapy to enhance aesthetics (Oringer and Iacono, 1999). The outcome of an associated treatment consists on tooth tissues restoration, providing a satisfactory biomechanical behavior on function (Machado et al., 2015) and gingival recession treatment with root coverage procedures restoring esthetic (Zucchelli et al., 2011). These procedures guarantee better margin stability because of the increased thickness of the tissue.

The increasing association between the two disorders occurring concurrently in the same tooth leads to a combined defect that may have a different prognosis regarding soft tissue coverage after periodontal surgery when compared to intact roots (Santamaria et al., 2007; 2009; 2013). Despite this close relationship between these two phenomena, literature shows different treatments for hard tissue reconstruction, without ample consideration to the presence of gingival recession or the final overall esthetic result. Even gingivectomy has been performed to allow isolation of the non-carious cervical lesion and the restorative procedure (Chan et al., 2014). Nevertheless, tissue excision procedures can alter the normal position of the gingival zenith, leading to esthetic damage. In order to obtain an optimal functional and esthetic result combined application of tissue grafts and restorative procedures may be required (Terry et al., 2003).

In this study, the combined defect gingival recession associated to non-carious cervical lesions was treated by connective tissue graft with coronally advanced flap and Lithium dissilicate ceramic partial veneers.

Case description and results

A 47-year-old female patient, in good systemic condition, complained of poor esthetics and increasing teeth sensitivity. Buccal NCCLs and GRs were found on left maxillary lateral incisive, canine and first premolar (Figures 1 and 2). The NCCLs were active, since they were exposed to oral environment and still undergoing the etiological factors action. At clinical examination, 1, 2 and 1.5 mm of probing depth was observed, respectively, and there was 2-3 mm of healthy keratinized tissue and sound interdental papillae. The gingival recession's dimensions were obtained using periodontal probe and 1, 2 and 2 mm height were observed, respectively. Cone bean computer tomography presented no bone loss of alveolar ridge. After clinical evaluation, the patient was asked to complete a diet diary to report all types of food and beverage ingested for a week. Analyzes were made and the main contributing factors were found. They were: thin gingival biotype, traumatic occlusion and consumption of acidic beverages, citrus fruits and juices. The patient was advised to reduce her consumption of acidic beverages such as improve her dental hygiene, thus collaborating for the success of the treatment.

Full-mouth radiographs, periodontal charting, study casts and a careful medical and dental history were obtained. Also, a complete photographic documentation of the case was carried out. Treatment goals were: 1) etiologic factors management, 2) restorative treatment of the NCCL and consequently reduction of teeth hypersensitivity, and 3) surgical harmonization of gingival architecture with connective tissue graft coronally advanced flap.

The depth of the NCCL and extension of the GR on canine can be noticed from a profile view (Figure 3). At lateral tooth the presence of GR and the absence of enamel and/or dentine structure loss can be observed, however, it is important to highlight that there is already minimal damage to enamel, dentin and cementum that could evolve to NCCL cavity. Thus, its ideal treatment does not pass through restorations because of the minimal wear, but the etiological factors management and surgical treatment step is fundamental to prevent the increase of the GR and the formation of a NCCL. The first premolar already presented a composite resin restoration, which was removed and exchanged.

With that clarified, occlusal interferences and premature contacts were checked. Occlusion adjustment was performed after planning on semi-adjustable articulator, using selective grinding with fine grit diamond burs (KG Sorensen, Brazil), providing harmonic occlusal contacts and preventing new areas of stress concentration (McHorris, 1985).

Canine and first premolar were restored with Lithium dissilicate partial veneers (IPS e.max Press, Ivoclar Vivadent, Liechtenstein). Polyvinyl siloxane (President, Coltene, Switzerland) impression was performed and retraction cord (Pro Retract #000, FGM, Brazil) used in order to enable subgingival impression (Figure 4). The ceramic restorations were prepared and the adaptation between tooth structure and periodontal tissue was checked before cementation. The internal surfaces of veneers were etched with 10% hydrofluoric acid for 20 seconds (Condicionador de Porcelanas, Dentsply Brazil; Figure 5). The surfaces were washed with water, dried and 37% phosphoric acid was applied for 60 seconds for cleanness (Schotbond Echant, 3M ESPE, MN, USA; Figure 6). The partial veneers were treated with a silane-coupling agent (Ceramic Primer, 3M ESPE, MN, USA; Figure 7). The enamel was etched with 37% phosphoric acid for 30 seconds (Total Etch, 3M ESPE). Adhesive layer (Single Bond Universal, 3M ESPE) was applied on the enamel and dentine according to manufacturer's protocol. It was used 100% photo-cure resin cement (Rely X Veneer, 3M ESPE) for luting the veneers and provide the highest color fidelity and stability. The surfaces were photo-activated for 60 seconds by a power LED 1200 mW/cm2 (Radii Plus, SDI, AUS; Figure 8) (Soares et al., 2014). Then, cervical finishing using ultrafine grit burs (#3070FF, KG Sorensen) and rubber points (8090D, KG Sorensen) with diamond paste (Diamond Gloss, KG Sorensen; Figure 9).

Root coverage was also indicated since gingival recessions resulted in esthetic problems reported by the patient and no signs of infectious or inflammatory periodontal issues were found. This set of characteristics observed on the patient leads to the indication of the associated restorative and surgical treatment. Periodontal surgical correction of the gingival recession was performed after polishing of restorations. The association of techniques (CTG + CAF) has been reported as the most predictable results for root coverage (Cairo et al., 2014). The elected surgery technique was subepithelial connective tissue graft combined with coronally advanced flap.

Supplemented with local anesthesia (Mepivacaine 2% with epinephrine 1:100,000 Nova DFL, Brazil), an intrasulcular incision was performed extending from the second premolar to the central incisor. The flap was then divided, in a partial way, giving mobility to the tissue. The field was cleaned by saline solution and 37% phosphoric acid (Schotbond Echant, 3M ESPE) was applied for 60 seconds to decontaminate both restorations (Figure 10). Tetracycline mixed with saline solution was applied for 3 minutes for the root decontamination and chemical preparation (Figure 11). After that, the solution was removed and the roots were rinsed with saline solution.

The donor site was the palate region of left premolars. The graft was removed and put in position, overlaying teeth lateral incisor, canine and first premolar (Figure 12). The ideal height of the papilla in a tooth with gingival recession was defined as described by Zuchelli (Zucchelli et al., 2006). The suture was made by the flap displacement to coronal position (Figure 13) and the palate was closed with a scalloped continuous suture (Figure 14). Postoperative instructions were given for patient and anti-inflammatory medication prescribed (ibuprofen 400 mg three times a day for 3 days). Chlorhexidine 0.12% mouthwash with was prescribed, twice a day for 7 days, when sutures were removed and regular brushing could be resumed. The association of surgical and restorative treatment was planned once an association of GR and NCCL was simultaneously affecting the patient. The recovery of dental tissues lost (enamel and dentin) must be considered as important as reestablishing soft periodontal tissue position for achieving health and esthetic results. The healing was uneventful.

One year later, the patient was evaluated (Figures 15 and 16). The condition of gingival tissue and restorations were satisfactory. There was no hypersensitivity dentin, no probing depth greater than 2mm, no bleeding on probing, low plaque index and no clinical inflammation aspects on gingival margin.

Discussion

Currently, the NCCLs' etiology had been very discussed among researchers and dental professionals. The clinician should consider all etiologic and modifying factors before completing the diagnosis or initiating treatment. The first treatment step of this clinical problem should be the elimination or management of all potential etiologic factors associated with the occurrence of gingival recession and non-carious cervical lesions. Detailed clinical examination is important for identification of gingival inflammation, periodontal disease, traumatic tooth brushing, excessive consumption of acidic beverages, citrus fruits and juices, dietary disorders, parafunctional habits and signs of traumatic occlusion (Santamaria et al., 2007; Grippo et al., 2012).

The treatment of the NCCLs should begin with the control of patient's diet, in order to reduce the acid food on diet. Then, the occlusal stability should be checked and treated if needed and only afterwards, the restoration should be done. The restoration of the NCCLs was important to reduce stress concentration, decrease of abfraction progression, strengthening the tooth, preventing pulp involvement and avoid biocorrosion, fracture, root caries, toothbrush abrasion and cervical sensitivity. (Levicth et al., 1994; Gripo at al., 2012, Soares et al., 2014).

A study using finite element analysis models to evaluate the effect of NCCLs on the biomechanical behavior of maxillary premolars, reported that the load type and the presence of restoration were the major factors associated with the stress distribution patterns on a tooth. In non-restored models, the load produced a large accumulation of stress at some point in the NCCL. These mechanical stress accumulations may be a factor that causes horizontal progression of NCCLs and GRs resulting in an increase in depth of the lesions, evidencing the importance of reconstruct the lost teeth structures (Soares et al., 2013; Soares et al., 2014).

On the other hand, localized gingival recession that occurs at the smile line may be also a great esthetic concern for the patient. There are many periodontal esthetic procedures used to treat this situation. Since 1985 the treatment of gingival recession has been influenced by the development of the subepithelial connective tissue graft technique, which has led to predictable and reproducible results (Allegri et al., 2010). The success of root coverage varies depending on the width and height of recession, biotype of gingival tissue, type of surgical technique used, and smoking status (Bherwani et al., 2014).

When only the NCCL is treated by a restorative procedure, the position of the gingival zenith is kept more apically due to the gingival recession persistence, resulting in a long tooth and consequently a possible esthetic disharmony (Santamaria et al., 2007; Chambrone and Chambrone 2006). In the same way, the surgical procedure alone cannot provide full rehabilitation of the patient condition. The depth of the NCCLs would not allow adequate root planning and would not solve the tooth biomechanical problem. Thus, restorative-periodontal combined approach might be the ideal treatment for the association between NCCLs and GRs (Deliberator et al., 2012; Santamaria et al., 2013).

The influence of composite resin and resin-modified glass ionomer restorations on subgingival biofilm was evaluated (McLaren, 1998). The hypothesis that connective tissue grafts could provide stable outcomes after 2 years of follow-up, regardless of the presence or absence of glass ionomer restorations in the treatment of these combined lesions has been confirmed. (Santamaria et al. 2013). The composite resin restoration of NCCLs with connective tissue graft for gingival recession treatment revealed low gingival inflammation, plaque accumulation, periodontal pockets, or bleeding on probing after 24 months of post-operative follow-up and an important factor responsible for this behavior is satisfactory polishing and finishing (Santos et al., 2007).

Besides other restorative materials available, as glass-ionomer, resin-modified glass-ionomer and flowable composite resin, the use of composite resin cores associated to glass ceramic laminates for restoring deep NCCLs, or just the glass ceramic laminates, for restoring the shallow ones, also appears a suitable restorative option (Machado et al, 2015).

The ceramic material used in this study was lithium dissilicate. The biocompatibility of this restorative material favor the healing of connective tissue grafts due to their satisfactory smoothness and refined surface and may also facilitate the adherence of the junctional epithelium to the restoration when applied subgingivaly. All of these features avoid gingival inflammation and favors the healing of connective tissue grafts, which is one of the main goals of the treatment (Seghi and Sorensen, 1995). Besides, ceramic veneers ensure greater preservation of tooth structure, maintain tooth vitality, and produce predictable results, having failure rates of only 0% to 5% over 1 to 5 years (Peumans et al., 2000).

Moreover, aesthetics is also improved when ceramic restorations are used. The glassy finishing of ceramics provides suitable surface smoothness and shine, making these restorations esthetically and biologically satisfactory (Peumans et al., 2000). A good environment for root coverage and regularization of gingival architecture can be obtained when ceramic partial veneers are used for NCCLs restoration. On the other hand, it is important that the clinicians analyze financial viability of these procedures, since they involve higher costs than composite resin and glass ionomer direct restorations (Machado et al., 2015).

The high prevalence of NCCLs and GRs demands constant advancement of treatment protocols and the use of lithium disilicate-reinforced glass ceramic restorations associated with connective tissue graft and coronary advanced flap is presented as a good alternative to aesthetic and functional rehabilitation for these cases.

The results of this clinical report were the same as found in previous reports. The presence of a restoration not only did not have any negative effect on the degree of root coverage, but also significantly improved the esthetic outcome of the therapy and the biomechanical behavior of the teeth. Despite the limited histological evidence on this combined therapy (Alkan et al., 2006) it has been shown that long junctional epithelium and connective tissue attachment formation are directly related to the degree of finishing and the compatibility of the restoration material. The absence of any significant alteration of periodontal clinical parameters (probing depth, bleeding on probing, plaque index and clinical inflammation aspects) over time seems to be justified by the absence of any violation of the biological width (Bherwani et al., 2014).

This protocol showed root coverage improvement without damage to periodontal tissues. The relation with ceramic restoration and gingival graft was positively supported by 1 year of clinical effectiveness. The results showed that the restorations did not interfere on optimal healing process, increase the esthetic aspects and reduce the dentin hypersensitivity. It is relevant to evaluate whether these successful outcomes remain stable, because the true benefit for the patient is the stability of results over time. It is important to consider the patient's oral hygiene for the long-term predictability of the clinical outcomes achieved. Therefore, further studies are necessary for evaluation of the amount of root coverage achieved on previously restored roots and its long-term maintenance.

Conclusion

Within the limitations of this case report, it can be concluded that the use of lithium disilicate-reinforced glass ceramic associated with connective tissue graft and coronary advanced flap for rehabilitation of patients affected by NCCL and GR may represent a predictable treatment option since there were no signs of inflammation, bleeding, periodontal pocket formation, or restorative failure. However a careful anamnesis and etiological factors management should be performed in order to confirm the indication of the associated protocol. Patients with acidic dietary habits, gastric dysfunction, occlusal problems, and smokers, affected by periodontal or systemic uncontrolled disease are not supposed to undergo the proposed treatment.

Acknowledgements

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Figures and legends:

Fig 1. Buccal view of the patients initial aspect.

Fig 2. Lateral view of gingival recession and noncarious cervical lesions in maxillary teeth (incisor, canine and premolar).

Fig 3. Profile view of the depth of the NCCL in canine and premolar.

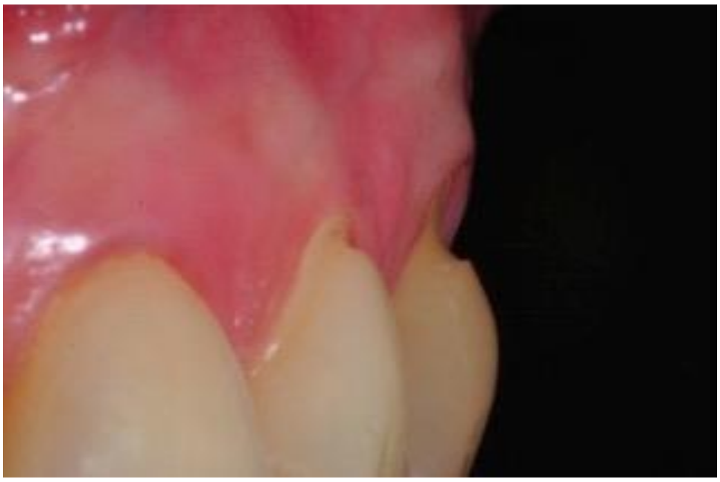

Fig 4. Impression of NCCLs for ceramic restoration confection.

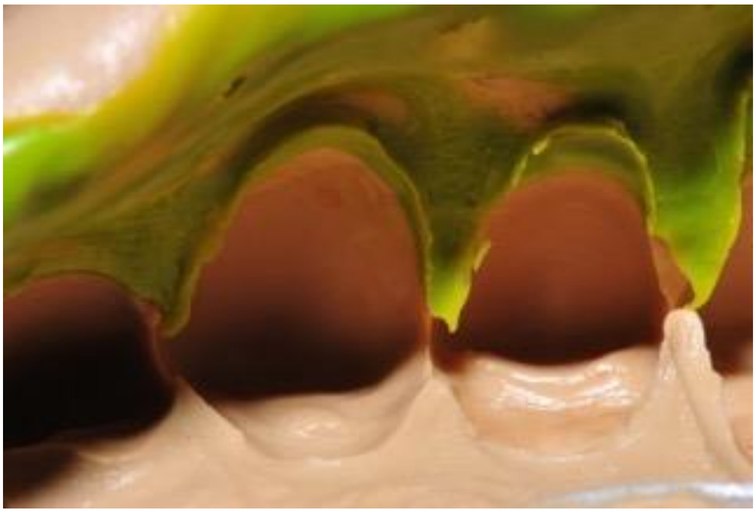

Fig 5. Conditioning treatment of the veneer with 10% hydrofluoric acid for 20 seconds (Condicionador de Porcelanas, Dentsply Brasil).

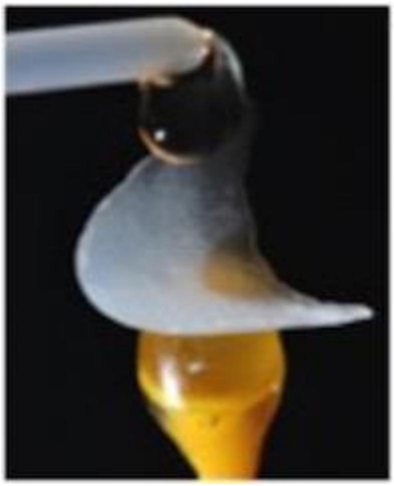

Fig. 6. 37% phosphoric acid application for 60 seconds for the cleaning of the veneer. (Total Etch, Ivoclar Vivadent).

Fig. 7. Silanization of the veneer (Monobond Plus, Ivoclar Vivadent).

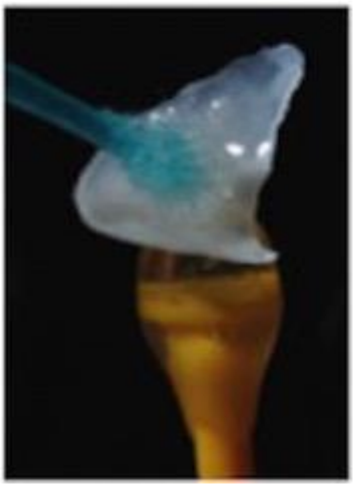

Fig 8. 40s Light-curing of resin cement by high intensity LED.

Fig 9. Lateral view of partial ceramic veneers cemented in cervical regions.

Fig 10. Decontamination of restorations: canine and first premolar with 37% phosphoric acid for 60 seconds.

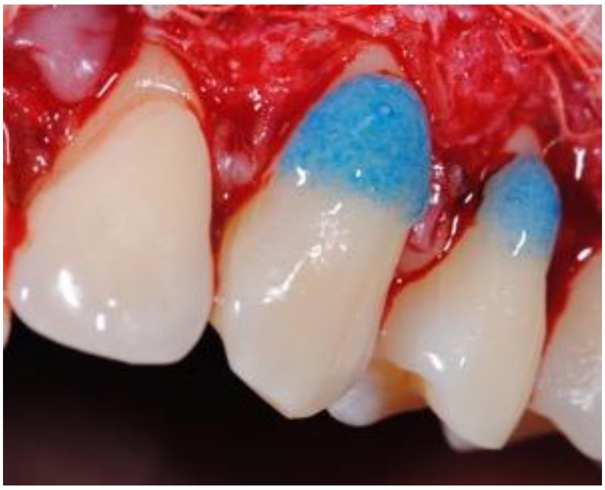

Fig 11. Root treatment with tetracycline mixed with saline solution for three minutes.

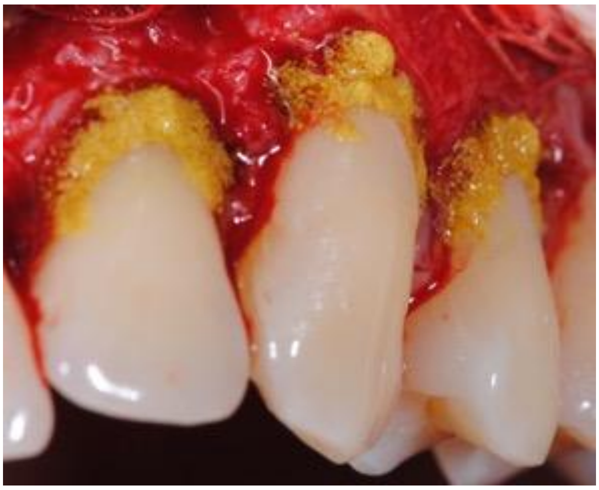

Fig 12. Graft in position, removed from left side of palate.

Fig 13. Coronary advanced flap.

Fig. 14. Scalloped continuous suture of the palate.

Fig 15. Clinical aspect of tissue and restorations, after one-year of the surgery. No clinical signs of inflammation were observed.

Fig 16. Lateral view of tissue and restorations, after one-year of the surgery.

Capítulo 4

Restorative and surgical treatment for non-carious cervical lesions associated with gingival recession: Preliminary results of a randomized controlled clinical trial

Journal of Periodontal Research

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Introduction

Non-carious cervical lesions (NCCLs) are a common finding in daily practice. This condition can lead to pronounced aesthetic limitations and, in extreme cases, to tooth fractures due to the weakening caused on tooth structures. (1) Some studies have shown that the biomechanical behavior of tooth is seriously affected by the presence of NCCLs, either on physiological/functional demands, or when interferences/pathological occlusion are present. (2)

It is generally accepted that NCCLs are not generated by isolated factors, but may result from a combination of multiple elements. (3, 4) Among the main factors proposed to be related to the formation and progression of NCCLs are: biocorrosion (chemical, biochemical and electrochemical degradation) caused by intrinsic and extrinsic acids; friction (wear) caused by traumatic brushing; and stress (abfraction) possibly caused by parafunction, traumatic occlusion and/or excessive loading. (3) Thus, the initial treatment planning for NCCLs should comprehend removal or at least management of etiological factors in order to improve the longevity of the following restorative procedures.

Several direct restorative materials, such as glass ionomer cements, (5) flowable composites, (6) and microhybrid or nanofilled composite resins, (4) can be used to restore NCCLs. The choice of the most appropriate material depends on aesthetics, presence of dentinal hypersensitivity and on the amount and condition of the remaining tooth structure. Composite resins have shown good clinical outcomes, presenting satisfactory adhesion, esthetics and longevity, (7) besides being less affected by chemical degradation when compared to glass ionomer cements. (8) Moreover, composite resins present similar mechanic and optical properties to dentin, (4, 7) making this material suitable to restore dentin structure losses in NCCLs. However, restorative materials that can replace enamel properly should also be applied, intending to mimic its physical and mechanical behavior. On this way, reinforced glass-ceramics can be a good choice for restoring enamel losses in NCCLs, since they present close properties to enamel and its laminates can be used on regions of high mechanical loading that demand aesthetics. (9, 10)

The exposure of root surfaces resulting from gingival recessions may be due to several etiologic factors, including periodontal disease, mechanical forces such as faulty tooth brushing, iatrogenic factors like uncontrolled orthodontic movement and improper restorations, viral infections of the gingiva, anatomical factors such as tooth malposition and frenum pull. (11) Marginal tissue recession results in dental hypersensitivity, esthetic complaints and a tendency toward root caries. (12)

Non-carious cervical lesions and gingival recessions (GRs) are closely related to each other, in both etiologic factors and therapeutic procedures. (13) The increasing association between the two disorders occurring concurrently in the same tooth, leads to a combined defect that may have a different prognosis regarding soft tissue coverage after periodontal surgery, when compared to intact roots. (14, 15)

Many studies confirmed that Miller Class I and II gingival recessions, (16) without interproximal structure loss, can be predictably treated and recovered with gingival tissue using surgical techniques as coronally advanced flaps (CAF), free gingival grafts (FGG) and sub-epithelial connective tissue grafts (CTG). However, the CTG associated with CAF is considered the gold-standard for its high predictability for root coverage. (17-19)

The histologic evidence derived from animal studies or from studies which realized the biopsies after the extraction of the concerned teeth for various reasons, shows that the CAF+CTG technique was associated to some degree of periodontal regeneration. (20-22) However, despite connective insertion expected from healing after root coverage with CAF+CTG, long connective tissue attachment occur in many situations, (20) when no periodontal regeneration associated with the root coverage procedure is observed in which the healing process is characterized by a long junctional epithelium (23, 24) even when a restorative material is present on root surface. (25)

A multidisciplinary approach to deal with this condition has been proposed in order to optimize the final esthetic outcome. Periodontal surgery is majority associated with restorative therapy to enhance aesthetics (26). The outcome of an associated treatment consists on tooth and tissue restoration, providing a satisfactory biomechanical behavior on function (27) and gingival recession treatment with root coverage procedures restoring esthetic (28). These procedures guarantee better margin stability because of the increased thickness of the tissue.

The aim of this randomized controlled trial (RCT) is to assess the associated restorative and surgical treatment for patients affected by non-carious cervical lesions and gingival recession in the same teeth, which need the both protocol for achieving a complete rehabilitation. The null hypothesis is that composite resin and ceramic restoration will provide no different healing outcome of CAF+CTG surgery when the associated treatment is performed.

Material and methods

Study design

The present study is reported according to the CONSORT statement for improving the quality of reports of parallel-group randomized trials (http://www.consort-statement.org/). This was a blinded, randomized, single-center clinical trial on the treatment of non-carious cervical lesions associated with gingival recession. Two different treatment modalities were compared: Non-carious Cervical Lesions restored with composite resin (CR group) or ceramic (C group), both with Gingival Recession treated using Coronally Advanced Flap (CAF) with a Connective Tissue Graft (CAF+CTG). The two arms were also compared with a control group: teeth presenting gingival recession without NCCL cavity already formed, in which treatment consisted of surgical step only (CAF+CTG).

The study was approved by the Ethical Committee of the School of Dentistry Federal University of Uberlandia (Protocol n. 379.492, August, 2013).

Participants

Nine patients, 4 male and 5 female were enrolled at the Non-Carious Cervical Lesion and Cervical Dentin Hypersensitivity Research and Extension Center, School of Dentistry, Federal University of Uberlandia, between October 2013 and January 2014. Informed consent was obtained from all the subjects included in the study.

Participants satisfying the following entry criteria were recruited: minimum age of 18 years, no systemic diseases or pregnancy, no systemic antibiotic therapy in the last 6 months, no smoking, no active periodontal disease, no site showing probing depth >2 mm, no history of mucogingival or periodontal surgery at the experimental site, presence of at least two teeth presenting buccal NCCL with clinical cavity formed and gingival recession (GR), and presence of only GR without clinical identifiable tooth hard tissue lost. Only GR and NCCL localized at upper central and lateral incisors, canine, first and second pre-molars associated with aesthetic problems were considered.

Each patient contributed at least with two teeth with NCCLs and GRs localized in the area of interest. Thus, each tooth represented an experimental unit. When patients presented the mentioned condition in teeth out of the site described, the teeth were treated but not considered for analysis. Among the experimental units, the selection of which group it would be allocated was performed by tossing a coin.

Patients with teeth affected by caries, gastroesophageal reflux disease, unsatisfactory prosthetic crowns, unidentified mucogingival lesions or without occlusal stability were excluded.

Sample size

The sample dimension was calculated using a = 0.05 and the power (1-b) of 80%. The minimum clinically significant success (d) considered for restorative and surgical treatment is 95% and 70 patients (mean of 5 NCCLs and GR each) were recorded up to the moment of the sample analysis. Calculations were performed according to the literature. (29) On the basis of these data, the needed number of teeth to be enrolled in this study was 15 for the test group (CR-CAF+CTG), 15 for the second test group (C-CAF+CTG) and 15 for the control group (CAF+CTG). However, the number of teeth was increased in 20% for each arm considering the possibility of dropouts of the patients.

Interventions

Pre-treatment

After clinical examination, all the patients underwent a prophylaxis and oral hygiene orientation section and were asked to complete a diet diary, to report all types of foods ingested for a full week. After analyzing the dietary habits, the patients received orientation about minimizing acidic food and beverage due to its relevance on NCCL formation.

Following the multidisciplinary analysis, the patients were instructed to reduce the frequency of ingestion of acidic foods. Full-arch impressions of the jaws were taken with irreversible hydrocolloid (Hydrogun, Zhermack, Badia Polesine, Italy) and type IV stone casts were poured (Durone IV, Dentsply, Petrópolis, RJ, Brazil).

Occlusal adjustment

The planning for occlusal adjustments using selective grinding consisted in first mounting study models on semi-adjustable articulator (Fig. 1) according to the parameters established by McHorris. (30) Then the occlusal analysis was performed on the semi-adjustable articulator models and the necessary adjustments were simulated in the study models. The compatibility of the regions of high spots and more intense contacts both in the stone was also verified clinically, allowing selective occlusal grinding to be performed.

Randomized allocation of teeth (experimental units)

After etiological factors management, the nine patients enrolled in this study, resulting in a total of 30 teeth presenting NCCL and GR and 15 teeth presenting GR without NCCL (constituting control group), had their teeth allocated in the experimental groups. The 30 teeth affected by NCCL and GR were allocated in CR Group or C Group by tossing a coin. The same patient had at least one tooth allocated in each experimental group (Fig. 2).

Experimental procedures

All procedures were performed by an expert operator with more than 10 years of experience. Experimental procedures were performed in the same clinic (Non-Carious Cervical Lesion and Cervical Dentin Hypersensitivity Research and Extension Center, School of Dentistry, Federal University of

Uberlandia) with high experience in providing direct and indirect restorative and periodontal treatments, including root coverage procedures.

Composite Resin Group

Teeth allocated in CR Group were treated following a single protocol, despite the depth of the lesions (from 1 to 2,5 mm). For performing the direct restorations cotton rolls and retraction cords (#00 or #000, Ultrapack, Ultradent, South Jordan, UT, USA) isolation (Fig. 4) was used after prophylaxis with pumice and chlorhexidine 0.2% (Fig. 5). Selective etching of enamel was conducted with 37% phosphoric acid for 15 s (Scotchbond Etchant, 3M-ESPE, St. Paul, MN, USA) and one-step self-etching adhesive system (Scotchbond Universal, 3M-ESPE) was applied on enamel and dentin and cured for 20 s with a LED curing unit with 1,200 mW/cm2 light output (Coltolux, Coltente, Feldwiesenstrasse, Switzerland) (Fig 6).

After, cavity filling was carried out using nanofilled composite resin (Filtek Supreme Ultra, 3M-ESPE) inserted in two or three increments and cured for 40 s each. Fine-grit conical diamond burs (#2135F, KG Sorensen, São Paulo, SP, Brazil), ultrafine-grit diamond burs (#2135FF, KG Sorensen) and silicone rubber points (#8193DFF, KG Sorensen) associated to diamond paste (Diamond Gloss, KG Sorensen) were used to polish and finish the restorations, improving surface smoothness and aesthetics (Fig 7).

Ceramic Group

Treatment planning for the NCCLs of C Group was defined using composite resin core to recover dentin when necessary and lithium disilicate-reinforced glass ceramic laminates to replace enamel in order to mimic lost tissues. The extent of all NCCLs was evaluated and according to the amount of structure loss (> 1mm depth), a composite resin core was built up in order to replace lost dentin. For this procedure, the restorative protocol describe for RC Group was followed (Fig. 8). Then teeth were prepared for ceramic laminates by producing a 0.5 mm bevel in the occlusal margin of enamel with fine-grit conical diamond burs (#2135F, KG Sorensen, São Paulo, SP, Brazil) to improve aesthetics and also increase the taper of the prepare.

For the impressions, the gingival tissue was displaced using retraction cords (#00 and #000, Ultrapack, Ultradent, South Jordan, UT, USA). The cords were removed and a vinyl-polysiloxane material (Express XT, 3M-ESPE) was used to make impressions of the teeth, using a double impression technique (Fig 9). After polymerization, the impression tray was removed and following disinfection protocol (0.5% sodium hypochlorite), full-arch type IV stone casts were poured. The shades of teeth were checked using Vita Classical guide.

Lithium disilicate-reinforced glass ceramic laminates (IPS e.max Press, Ivoclar Vivadent, Schaan, Liechtenstein) with approximately 0.5 mm of thickness, were processed using conventional pressing technique associated to extrinsic characterization with stains (IPS Empress Universal Shade/Stains, Ivoclar Vivadent). First, the adaptation of the ceramic laminates to the tooth structures, their relationship to periodontal tissues and asymmetries were checked (Fig. 10). Next, the shade of the ceramic restorations to the tooth substrate was verified. The shades values were selected on the basis of try-in pastes from the resin cement set (Variolink Veneer, Ivoclar Vivadent), used to simulate the final shade of the ceramic laminates with the resin cement.

After this step, surface treatment of the laminates was performed by etching the internal surfaces with 9.5% hydrofluoric acid for 20 seconds (Condicionador de Porcelanas, Denstsply). Then, the ceramics laminates were cleaned with water spray, dried, and 37% phosphoric acid was applied for 60 seconds for removing compounds precipitated after previous etching. At last, the internal surfaces of laminates were treated with a silane coupling agent (Monobond Plus, Ivoclar Vivadent) applied actively for 20 s and left to react for 1 min (Fig. 11).

For the luting procedures, selective etching of enamel was performed with 37% phosphoric acid for 15 s, followed by active application of one-step self-etching adhesive system and photoactivation for 20 seconds. Photo-cure resin cement (RelyX Veneer, 3M-ESPE) was used to lute the ceramic laminates since it provides good color fidelity and stability. After positioning laminates on the NCCLs, excess resin cement was removed with disposable applicators and photoactivation was performed for 60 seconds with LED curing unit. Finally, cervical finishing was conducted with ultrafine-grit diamond burs (#2135FF, KG Sorensen) and silicone rubber points (#8193DFF, KG Sorensen) associated to diamond paste (Diamond Gloss, KG Sorensen), in order to improve adaptation and aesthetics (Fig. 12).

Surgical Procedure

The association of surgical techniques (CTG + CAF) was applied for both experimental groups (CR and C) besides control group.

Pre-operatory asepsis was performed using chlorhexidine 0.2% mouthwash for 1 minute and 2% solution for face skin cleaness. Following administration of local anesthesia (Mepivacaine 2% with epinephrine 1:100,000 Nova DFL, Brazil), an initial intrasulcular incision was made in the recession area of the tooth or teeth where root coverage was intended. The intrasulcular incision was extended to the mesial and distal line angles of the tooth or teeth being treated. A partial-thickness flap was reflected beyond the mucogingival junction as to expose at least 3 mm of periosteum and bone apical to the most apical margin of the bone dehiscence (Fig. 13).

The field was cleaned by saline solution and 37% phosphoric acid (Schotbond Echant, 3M ESPE) was applied for 60 seconds to decontaminate both composite resin and ceramic restorations (Fig 14). Tetracycline paste with saline solution was applied for 3 minutes for the root decontamination and chemical preparation (Fig 15). After that, the paste was removed and the roots were rinsed profusely with saline solution.

The donor site was the palate region of premolars for all patients (Fig. 16). The graft was removed and put in position, overlaying the roots of the teeth treated. The sutures were made by the flaps displacement to coronal position (Fig. 17) and the palates closed with a scalloped continuous suture. Postoperative orientations were given for the patients and anti-inflammatory and analgesic medication (Ibuprofen 400 mg three times a day for 3 days and Dipyrone 500 mg four times a day for 2 days) prescribed. A mouthwash with chlorhexidine 0.12% was also prescribed, twice a day for 7 days, when sutures were removed and regular brushing could be resumed.

Outcomes evaluation

Before restorative and surgical therapy the following gingival parameters, according to Santamaria et al., (15) were recorded: 1) PD – probing depth; 2) BOP - presence or absence of bleeding on probing at the site included in the study; (31) and 3) PI - presence or absence of visible plaque accumulation at the site included in the study. (32)

When treatment was completed, the same previously described parameters were recorded at the period of 3-months follow-up and two other were included: 1) OI – presence of occlusal interferences affecting the teeth involved in the study; 2) RA – restorative procedure analysis. (34)

Statistical analysis

Data recorded on follow-up were analyzed and Kruskal-Wallis One Way Analysis of Variance on Ranks and Mann-Whitney Rank Sum tests were conducted at 95% significance level using statistical package (SigmaPlot 12.0, Systat Software, San Jose, CA, USA).

Results

No statistical difference was detected among the groups. Tables 1 - 5 presents the data collected and statistical analyses results.

Discussion

The prevalence of NCCLs in the population becomes increasingly common since loss of tooth structure due to dental caries decreased and teeth remain for longer periods in contact with aggressive agents such as acid food and/or beverage and occlusal interferences present in the oral environment. (35) Repeated exposure to endogenous and exogenous acids associated with stress concentration favors the generation and development of NCCLs. (3) NCCLs and gingival recessions (GRs) are closely related to each other, in both etiologic factors and therapeutic procedures. (13) Therefore, in order to promote full rehabilitation of patients affected by these conditions, the etiologic factors should be carefully removed or managed. Occlusal adjustments and acid dietary control are important points to avoid the recurrence of non-carious cervical lesions and gingival recession already treated.

The occlusal adjustment procedures are traditionally planned using study models mounted on semi-adjustable/fully-adjustable articulators for analysis of possible dental interferences and problems. (30) The reestablishment of a balanced occlusion, in which masticatory load dissipates through the long axis of the teeth, avoids harmful stress concentration along the dental and periodontal structures and favors the long term survival of restorative procedures such as root coverage surgical procedures, since occlusal interferences are modifying etiologic factors for GR occurrence. (36) The assessment of occlusal parameters showed no occlusal interferences at 3-month flow-up favoring the periodontal tissue's health and restoration's integrity maintenance.

The restoration of NCCLs represents a major challenge for dental materials due to the amended adhesive properties of the sclerotic dentin and the biomechanical aspects of the cervical area (37) under physiological and pathological occlusion conditions, besides the different biomechanical behavior between dentin and enamel. The use of composite resin and ceramics to restore dentin, (38) and enamel, (39) respectively, results in a restorative complex able to mimic tooth structure as close to sound tooth as possible. The mechanical properties of both restorative materials allow them to behave such as natural tissues, enabling not only the restoration of rigid structures, but also to recover similar biomechanical behavior to healthy tooth.

Therefore, besides other available restorative materials as glass-ionomer, resin-modified glass-ionomer, (5) and flow composite resin, (40) which have proved to be good alternatives for the restoration of NCCLs, the use of composite resin core associated to ceramic laminate or just ceramic laminates favors a more accurate restoration of lost structures due to the similarity between restorative materials and tooth tissues. Composite resins present mechanical properties closer to dentin; (38) however, they are not capable to mimic the thin enamel tissue on the cervical region. For this reason, the association of composite resin cores with thin ceramic laminates to restore NCCLs results on a restorative complex with biomechanical behavior similar to sound tooth structure. (27)

The association of restorative and periodontal treatment seems to enable full rehabilitation of teeth affected by NCCL and GR. (15, 41, 42) The first 90-day follow-up of this study shows a successful healing process in progress. It was observed no probing depth >2mm, no bleeding on probing, despite plaque was observed in same treated teeth.

The multiple etiologic agents responsible for the formation and progression of NCCLs and GR must be managed in order to improve treatment predictability. The dietary condition of the patient must be controlled avoiding acid food and preventing recurrences. In addition to that, ceramic restorations show good performance in acidic environments, brush abrasion and thermo-mechanical loading.

Moreover, aesthetics is also improved when ceramic and composite resin restorations are used. The glassy finishing of ceramics provides suitable surface smoothness and shine, making these restorations esthetically similar to enamel. Lithium disilicate-reinforced glass material enables ceramics to be widely used in dentistry, due to its good mechanical properties and excellent optical properties. (10) A better environment for root coverage and regularization of gingival architecture can be obtained with ceramic and well finished and polished composite resin restorations for NCCLs restoration, since these lesions usually present association with gingival recessions. Thus, as composite resin and ceramic restorations are widely used on dental practice regarding many kinds of tooth rehabilitation, it can also be successfully applied on the cervical region for restoring NCCLs, providing appropriate functional and aesthetic outcomes.

Conclusions

The high prevalence of NCCLs associated with GR demands constant advancement of treatment protocols and the use of composite resin and lithium disilicate-reinforced glass ceramic restorations are presented as good alternatives to aesthetic and functional rehabilitation of these cases. Both restorative materials are biocompatible and do not affect healing of connective tissue grafts when surgical root coverage procedures are needed as observed at 3-month follow-up.

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Conflicts of Interest

The authors of this manuscript certify that they have no proprietary, financial, or other personal interest of any nature or kind in any product, service, and/or company that is presented in this article.

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TABLES AND LEGENDS

Table 1. Probing depth assessment and statistical analysis result. Score (0) represent probing depth < 2mm and (1) >2mm.

Samples	***Scores***			***p* Value**
	GR	**CR**	**GC**	
1	0	0	0	
2	0	0	0	
3	0	0	0	
4	0	0	0	
5	0	0	0	
6	0	0	1	
7	0	0	1	
8	0	0	1	0.105
9	0	0	0	
10	0	0	1	
11	0	0	0	
12	0	0	0	
13	0	0	0	
14	0	0	0	
15	0	0	0	

Table 2. Bleeding on probing data and statistical analysis. Score (0) represents no BOP and (1) BOP event.

Samples	***Scores***			***p* Value**
	GR	**CR**	**GC**	
1	0	0	0	
2	0	0	0	
3	0	0	0	
4	0	0	0	
5	0	1	0	
6	0	0	1	
7	0	0	1	
8	0	0	1	0.153
9	0	0	0	
10	0	0	0	
11	0	0	0	
12	0	0	0	
13	0	0	0	
14	0	0	0	
15	0	0	0	

Table 3. Plaque index assessment; absent (0) and present (1) and statistical analysis.

Samples	***Scores***			***p* Value**
	GR	**CR**	**GC**	
1	0	0	0	
2	0	0	0	
3	0	0	0	
4	0	0	1	
5	0	0	1	
6	0	0	1	
7	0	1	1	
8	0	0	1	0.368
9	1	1	0	
10	1	0	0	
11	1	1	0	
12	0	0	0	
13	0	0	0	
14	0	0	0	
15	0	0	1	

Table 4. Presence of occlusal interferences (1) and no occlusal interferences found (0) and statistical result.

Samples	***Scores***			***p* Value**
	GR	**CR**	**GC**	
1	1	0	0	
2	0	0	0	
3	0	0	0	
4	1	0	0	
5	0	0	0	
6	0	0	0	
7	0	0	0	
8	0	0	0	1.000
9	0	0	0	
10	0	0	0	
11	0	0	0	
12	0	0	0	
13	0	0	0	
14	0	0	0	
15	0	0	0	

Table 5. Analysis of restoration integrity. Score (0) no problems regarding color, marginal adaptation, fractures, secondary caries or surface roughness were observed.

Samples (RI)	***Scores***		***p* Value**
	CR	**GC**	
1	0	1.000	
2	0	0	
3	0	0	
4	0	0	
5	0	0	
6	0	0	
7	0	0	
8	0	0	1.000
9	0	0	
10	0	0	
11	0	0	
12	0	0	
13	0	0	
14	0	0	
15	0	0	

FIGURES AND LEGENDS

Fig 1. Occlusal analyses and adjustment. A. Gypsum models on articulator. B. Contact areas used to guide on occlusal adjust.

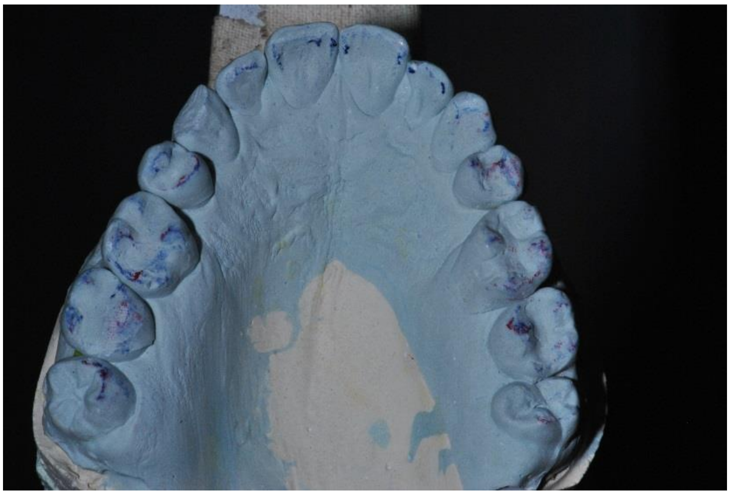
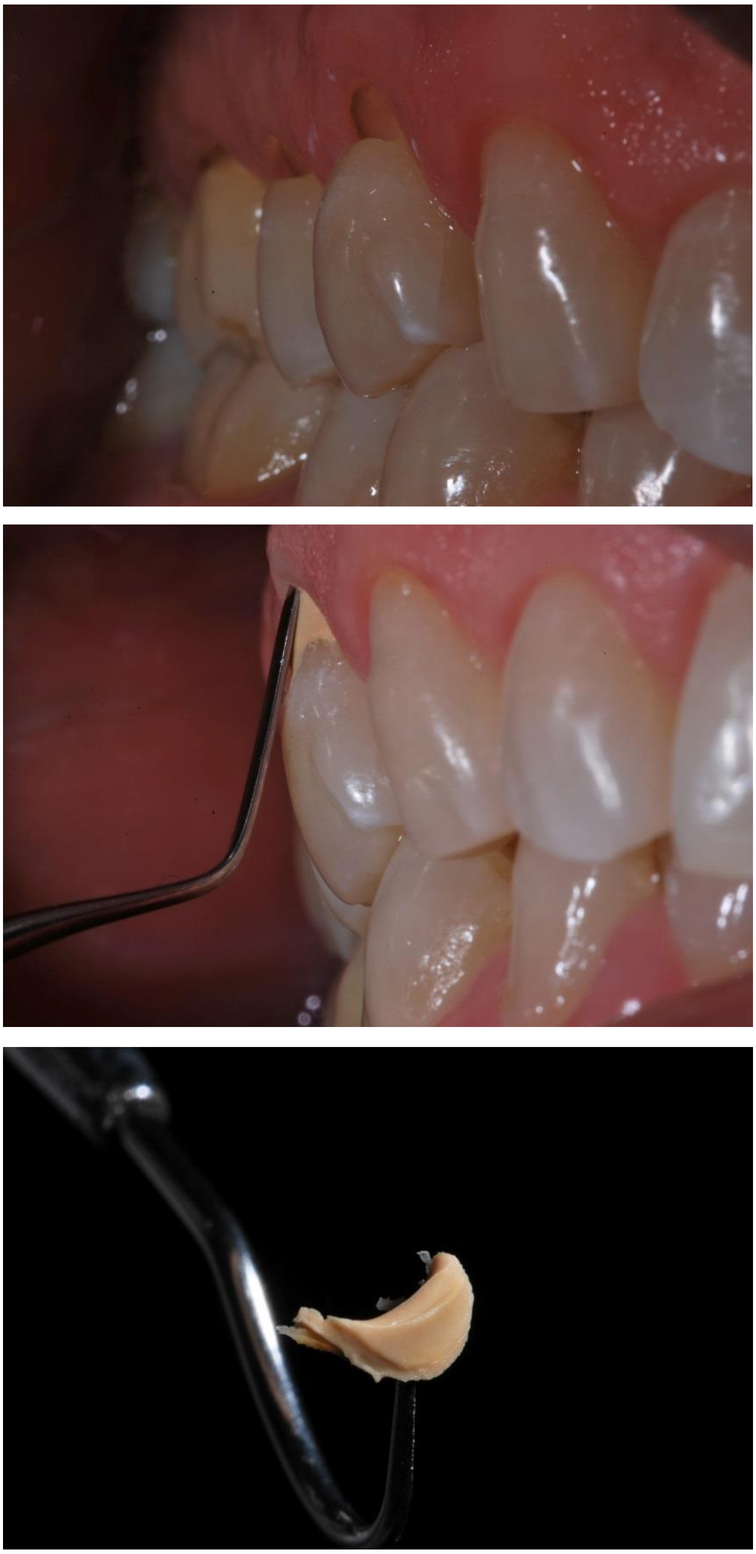
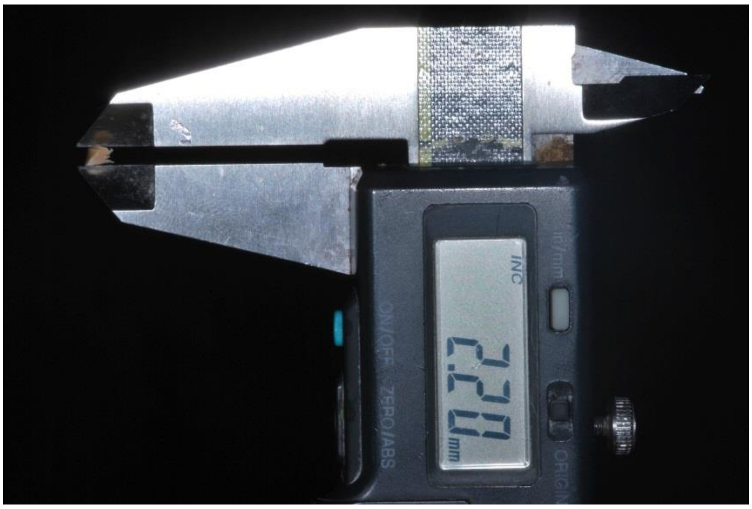


Fig 2. Initial teeth aspect and occlusion. A. Presence of several NCCLs. B. Right side, showing the relation of #13, #15 and #16. Tooth #13 was allocated on control group and #14 on ceramic group. Tooth #16 was restored but was not considered for the study.

Fig 3. A - Tooth #14 allocated on CR Group. B – Silicon impression for NCCL dimensional measurement. C – Impression measurement using digital pachymeter for obtaining NCCL's depth (D), wide (E) and height (F).

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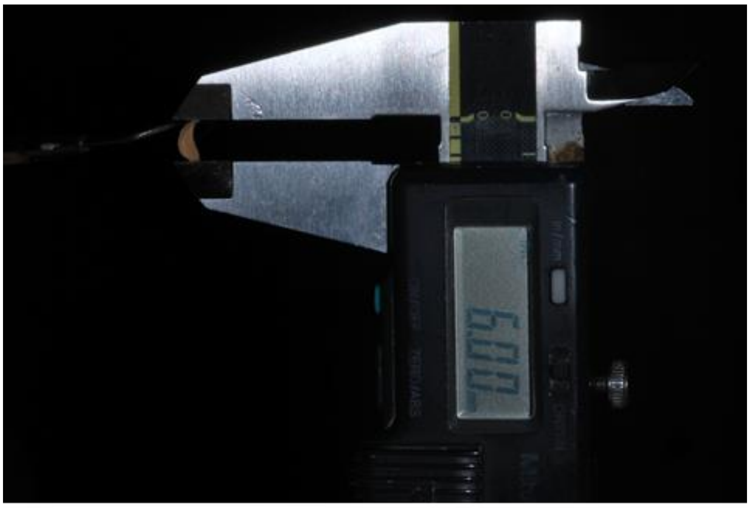
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Fig. 4 Retraction cord used for gingival displacement.

Fig. 5 Prophylaxis with pumice and 0.12% chlorhexidine.

Fig. 6 A – Correction of the NCCL's coronal angle for improving esthetical results of the restoration; B – 37% phosphoric acid etching; C – Full acid washing; D - Universal single bond application, first on dentin then on enamel; and E – Light-curing for 20 seconds.

Fig. 7 A and B – Nanofilled composite resin (Filtek Supreme Ultra, 3M-ESPE) insertion; C – Rubber silicone point for polishing; and D – Final aspect of the restoration.

Fig 8. Composite resin core. A. Surface clean with pumice-water past and retraction cord positioned. B. Enamel etching with 37% phosphoric acid. C. Single step self-etching bond application. D. Photoactivation of adhesive layer during 20s. E. Nano hybrid composite resin inserted after 40s photoactivation.

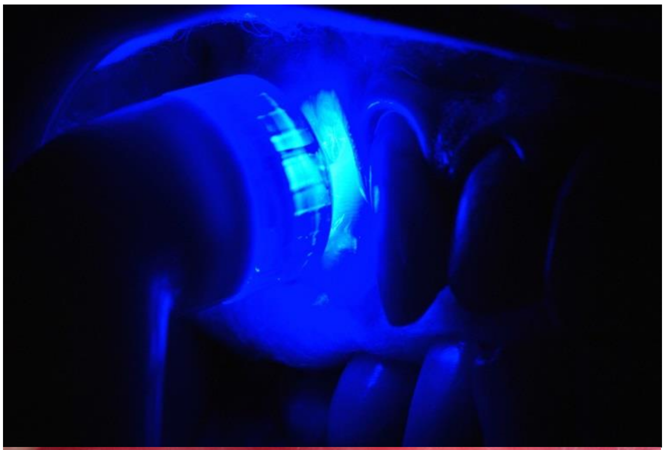

Fig 9. Minimally invasive preparation before silicon impression. A. Lateral view to retention area on enamel-composite resin interface. B. Bevel created only enamel by ultra-fine grid diamond. C. After bevel preparation. D. Light-body vinyl-polysiloxane was inserted, and air pressure was made. E. View after putty vinyl-polysiloxane impression.



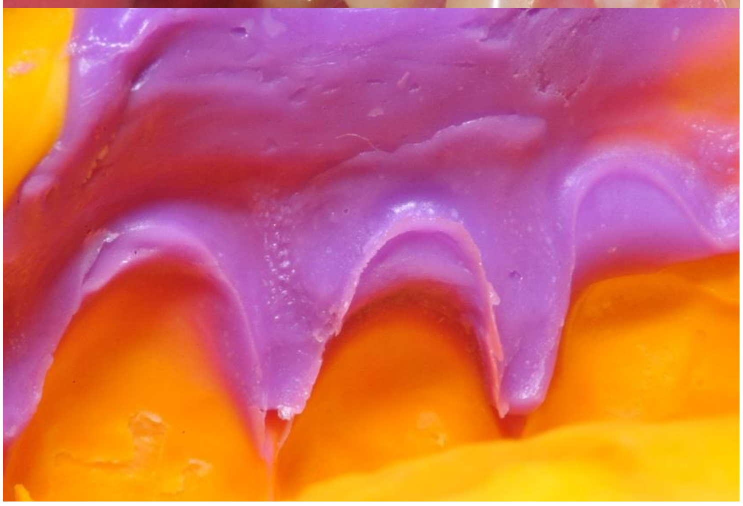

Fig 10. Class V indirect restoration of Lithium dissilicate ceramic. A. Try-in on model after confection by pressuring system and glazing. B. Lateral view of restoration, top side to adjust on cervical region and bottom side to accommodate on enamel-bevel. C. Thickness of restoration, 0.3-0.4mm. D. Adaptation of restoration with try-in past.

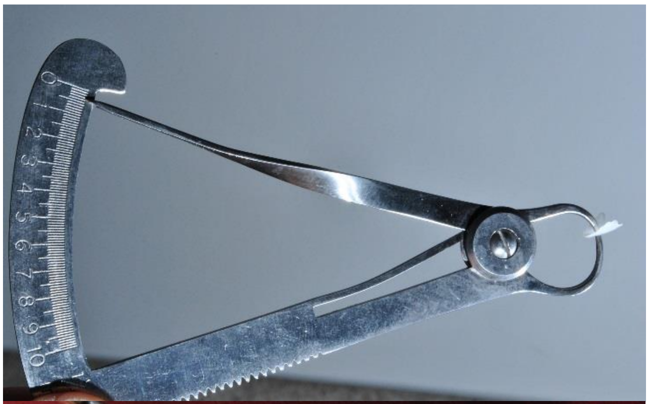
0 1 2 3 4 5 6 7 8 9 10

Fig 11. Surface treatment protocol of ceramic. A. 10% hydrofluoric acid for 20 seconds. B. Water washing during 60s, then 37% phosphoric acid application. C. Wash the phosphoric acid by 60s, and applied actively the silane bond agent during 20s. Wait at least 60s before adhesive cementation.

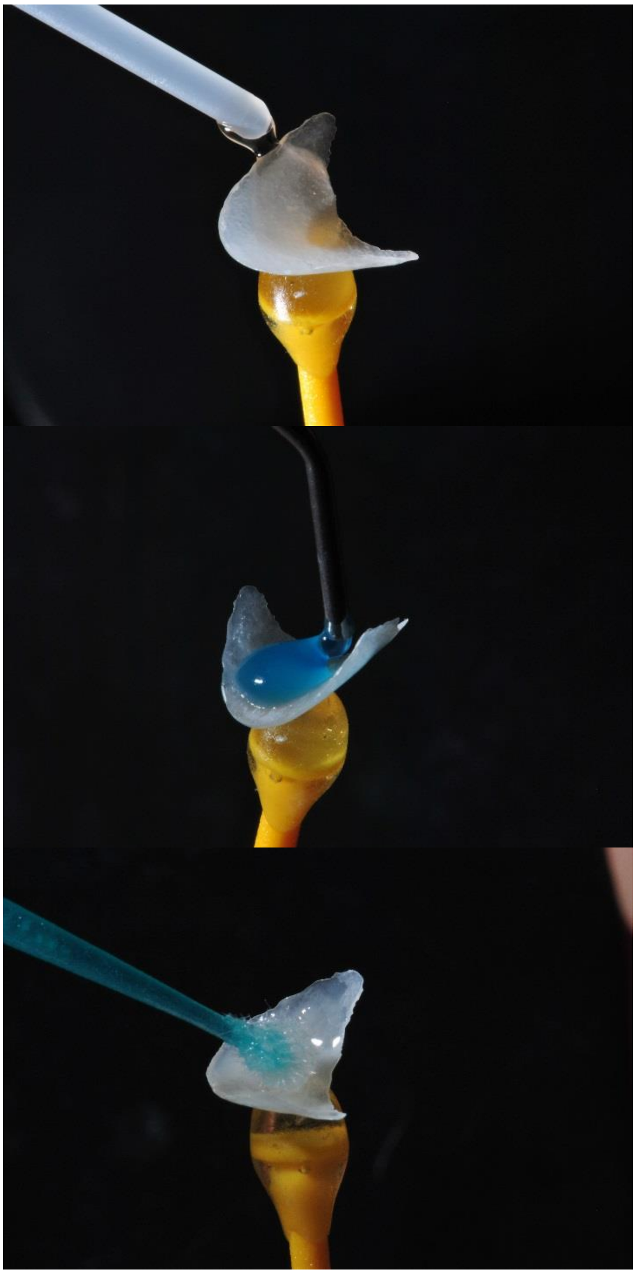

Fig 12. Luting procedure. A. Surface clean with pumice-water past and retraction cord positioned. Enamel etching with 37% phosphoric acid. B. Single step self-etching bond application and photoactivation of adhesive layer during 20s. C. Accommodation of ceramic restoration with photo-cured resin cement. Remove excess of cement with brush. D. Photoactivation by buccal face during 60s. E. Final aspect of teeth and ceramic restorations after finishing and polishing procedures.

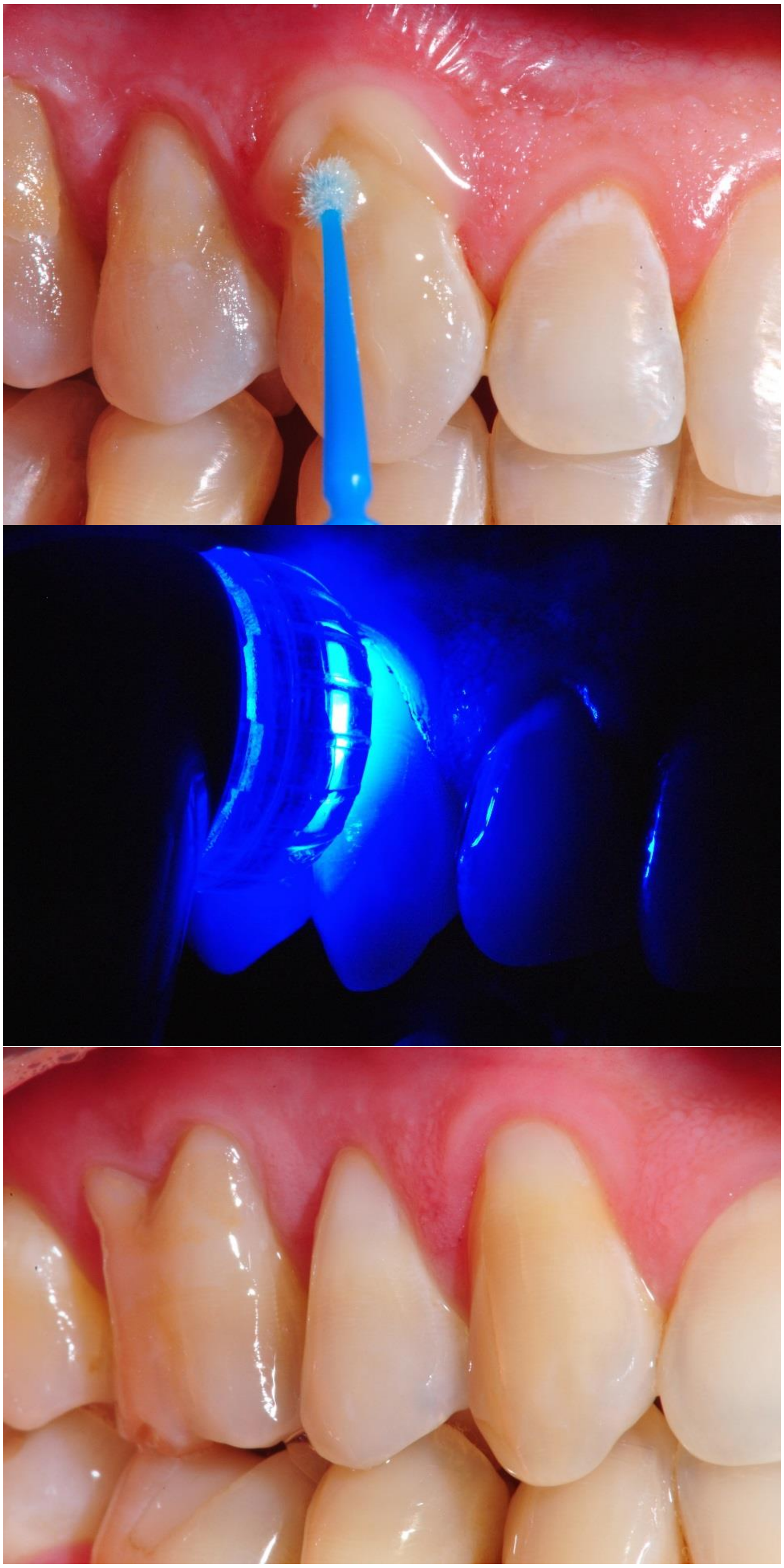

Fig. 13 Sulcular incision over muco-gingival union for available flap mobility.

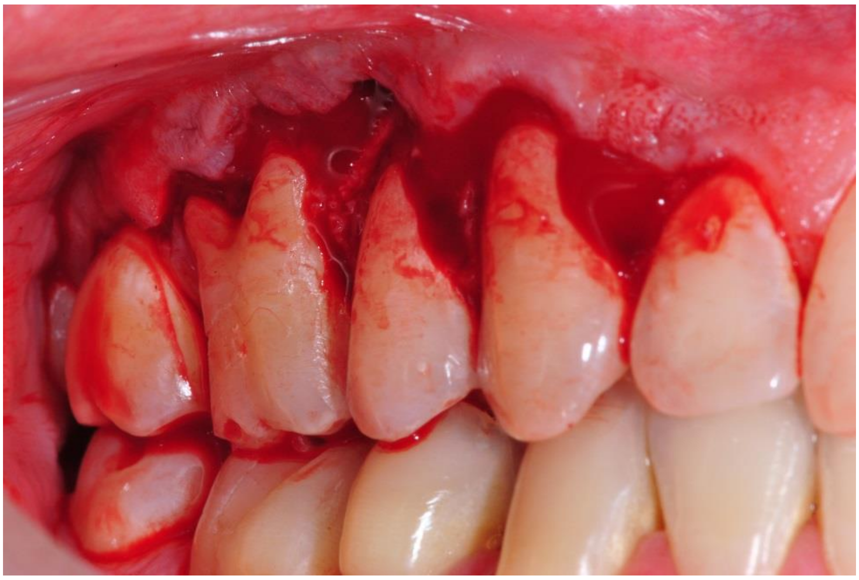

Fig. 14 Tetracycline chemical preparation of root surface.

Fig. 15 Phosphoric acid etching for cleaning restoration surfaces.

Fig. 16 Graft removed from palate.

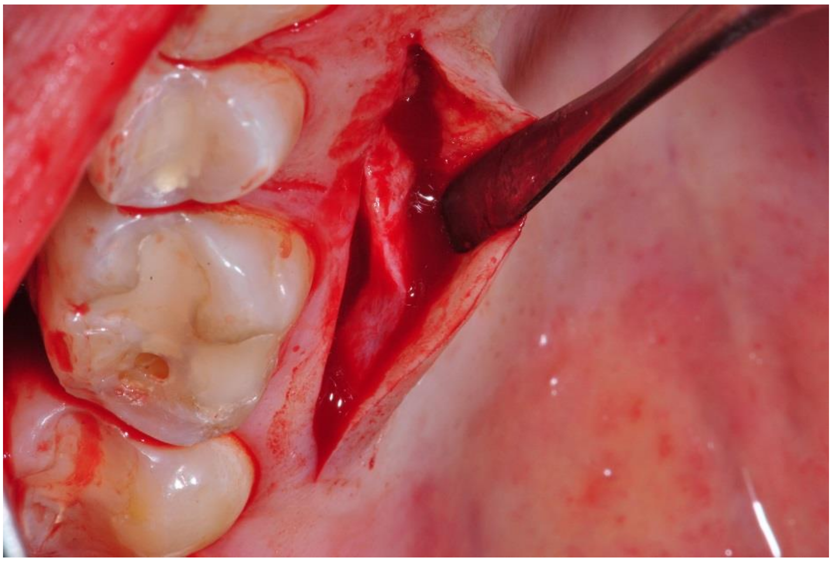

Fig. 17 Suture of the flap achieving a coronal position.

CONSIDERAÇÕES GERAIS

Diferentes níveis de bateria de unidades fotoativadoras de LED podem alterar a voltagem da bateria e a intensidade de luz emitida pelo aparelho, influenciando, consequentemente, o grau de conversão, a resistência à tração diametral, a capacidade de sorção e solubilidade de uma determinada resina composta nanoparticulada.

Os materiais restauradores utilizados na reabilitação de LCNCs não afetam negativamente a viabilidade celular de fibroblastos gengivais isolados em cultura primária em um período de análise de 24h. Discos de cerâmica (dissilicato de lítio) mostraram resultados favoráveis quanto à citotoxicidade em análise de 72h, apresentando-se como bom material restaurador para o tratamento de LCNCs associadas a RG com indicação de cirurgia periodontal para recobrimento radicular.

O relato de caso apresentado demostrou que, clinicamente, o emprego de restaurações indiretas em cerâmica para tratamento de LCNCs pode apresentar resultados favoráveis, mesmo quando aplicadas a dentes que receberão enxerto de tecido conjuntivo para tratamento da recessão gengival, após a conclusão do tratamento restaurador.

No acompanhamento de três meses do estudo clinico foram observados aspectos de normalidade do tecido gengival após enxerto de tecido conjuntivo para tratamento de recessão gengival em dentes acometidos por LCNC e que receberam restaurações em resina composta e cerâmica.

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ANEXOS

Anexo 1

Considerando que Clínica do Projeto de Extensão LCNC-FOUFU têm 70 pacientes cadastrados, uma precisão amostral de 5%, um nível de confiança de 95% e estimativa de 95% de sucesso na restauração dentária com resina e também na cirurgia, o tamanho amostral mínimo, de acordo a metodologia sugerida por Fonseca e Martins (2006):

$$n = \frac{Z^2 pqN}{d^2(N-1) + Z^2 pq}$$

é n = 30 sujeitos de pesquisa (15 em cada grupo).

FONSECA, Jairo Simon; MARTINS, Gilberto de Andrade, **Curso de Estatística**. 6ª edição, Ed. Atlas, 2006, 320p.

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Anexo 2

UNIVERSIDADE FEDERAL DE UBERLÂNDIA/MG

PARECER CONSUBSTANCIADO DO CEP

DADOS DO PROJETO DE PESQUISA

Título da Pesquisa: Reabilitação de pacientes acometidos por lesões cervicais não cariosas e comprometimento periodontal - estudo clínico prospectivo.

Pesquisador: Paulo Vinícius Soares

Área Temática:

Versão: 2

CAAE: 15062113.8.0000.5152

Instituição Proponente: FACULDADE DE ODONTOLOGIA

Patrocinador Principal: Financiamento Próprio

DADOS DO PARECER

Número do Parecer: 379.492

Data da Relatoria: 02/08/2013

Apresentação do Projeto:

Segundo apresenta o protocolo:

Estudo clínico prospectivo para determinar a superioridade da utilização de cerâmica como material restaurador de lesões cervicais não cariosas no tratamento de dentes com indicação de recobrimento radicular.

O autor informa "A coexistência de recessões gengivais (RG) e lesões cervicais não cariosas (LCNC) em regiões de importância estética gera a necessidade de um protocolo que respeite e favoreça a saúde dos tecidos dentários e periodontal e permita tratamento com previsibilidade. O objetivo deste estudo será verificar, por meio de avaliações clínicas, o comportamento do recobrimento de recessões gengivais sobreposto a restaurações diretas adesivas em resina composta e indiretas em cerâmica. Serão selecionados no mínimo oito e no máximo vinte e quatro pacientes com boa higiene oral e estabilidade oclusal diagnosticados com LCNCs nos dentes anteriores incluindo pré-molares associadas a recessões gengivais (classe I e II de Miller). Após exame clínico e tomográfico inicial, ajuste oclusal será realizado e os pacientes receberão um ou os dois tipos de tratamento, sendo restauração direta em resina composta da LCNC, polimento e tratamento da RG com recobrimento radicular, e restauração cerâmica indireta da LCNC e cirurgia periodontal para recobrimento radicular. As RG presentes em dentes superiores anteriores incluindo pré-molares

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que não apresentarem LCNCs serão tratadas com recobrimento radicular sendo este o grupo controle. Serão realizadas dezesseis cirurgias para recobrimento no grupo controle, dezesseis restaurações em resina composta com cirurgia para recobrimento no grupo RD e dezesseis restaurações em cerâmica com cirurgia para recobrimento no grupo RI Será feito acompanhamento clínico trimestralmente durante vinte e quatro meses. Os dados obtidos nas diferentes fases serão tabulados e submetidos à análise para detecção de distribuição normal e homogeneidade. Em seguida, será aplicada ANOVA e teste de Tukey (alfa=0,05). Pretende-se por meio deste projeto, definir o protocolo cirúrgico- restaurador que forneça resultados previsíveis favorecendo o tratamento de pacientes com a condição descrita.

Objetivo da Pesquisa:

Hipótese:

A superioridade de restaurações em cerâmica na reabilitação de lesões cervicais não cariosas em dentes com recess gingival tratadas com enxerto de tecido conjuntivo.

Objetivo Primário:

Analisar o comportamento de enxertos de tecido conjuntivo na presença de lesões cervicais não cariosas restauradas com resina composta e cerâmica, em dentes superiores anteriores de pacientes sem história de gengivite e periodontite.

Objetivo Secundário:

1. Avaliar a eficiência do recobrimento radicular sobre dois materiais restauradores diferentes comparados ao controle (sobre dente);
2. Avaliar a coexistência de interferências oclusais nos dentes que apresentem lesão cervical não cariosa;
3. Correlacionar a altura óssea do rebordo alveolar com a extensão e profundidade da lesão cervical não cariosa.

Avaliação dos Riscos e Benefícios:

Segundo os pesquisadores:

Riscos: O único risco apresentado é o de quebra de sigilo quanto à identificação dos pacientes que será minimizado pela codificação dos prontuários.

Benefícios: O benefício desta pesquisa é indireto, ou seja, os resultados melhorarão o tratamento para todos os pacientes que precisarem de tratamento semelhante.

Comentários e Considerações sobre a Pesquisa:

"Serão selecionados dezesseis dentes com RG sem perda de estrutura dentária, portanto, sem LCNC, sendo este o Grupo Controle. Serão selecionados trinta e dois dentes com RG e LCNC distribuídos em dois grupos com dezesseis dentes em cada, RD e RI. Os grupos controle, RD e RI serão tratados, apenas com cirurgia para recobrimento radicular, restauração direta em resina composta e cirurgia para recobrimento radicular e restauração indireta em cerâmica e cirurgia para recobrimento radicular, respectivamente. Na avaliação periodontal inicial serão observados o nível de inserção clínica (profundidade de sondagem + margem gengival), quantidade de gengiva inserida (mm) e sangramento à sondagem. Os pacientes passarão por tratamento periodontal básico com profilaxia, polimento dentário e orientações para escovação atraumática dos dentes.

1.2 - Protocolo de ajuste oclusal: Os pacientes terão suas arcadas moldadas para posterior obtenção de modelos em gesso. Em seguida, serão obtidos registros dos mesmos com auxílio de arco facial, jig e registro interoclusal em Relação Cêntrica para que os modelos possam ser então montados em articulador semiajustável (ASA). Será realizada análise e diagnóstico de possíveis interferências oclusais em posição de relação cêntrica (RC) e nos movimentos excursivos (na guia anterior, guia canina e/ou função em grupo).

Após detecção das prematuridades será realizado ajuste oclusal nos casos em que houver necessidade com o objetivo de promover contatos oclusais harmônicos e igualmente distribuídos em todos os dentes posteriores em máxima intercuspidação cêntrica, além de contato leve nos dentes anteriores e nas guias anterior e laterais, permitindo completa desoclusão dos dentes posteriores.

1.3 - Protocolo restaurador: Neste momento as LCNC serão divididas em dois grupos: RD (restauração direta) e RI (restauração indireta). As LCNC do grupo RD receberão restaurações adesivas Classe V em resina composta do tipo nanoparticulada (Filtek Supreme XT, 3M-ESPE, St. Paul, MN, USA) que apresenta boa resistência e bom polimento superficial. Após conclusão do procedimento restaurador será realizado criterioso protocolo de acabamento e polimento das restaurações previamente à realização da etapa cirúrgica, pois a previsibilidade desta está diretamente relacionada à lisura da superfície da restauração (Deliberador et al., 2012) (Santamaria et al., 2011). Para isso, as restaurações serão cuidadosamente acabadas em nível do tecido dental utilizando pontas diamantadas de acabamento de granulação fina e extra-fina (Kit Acabamento, KG Sorensen, Barueri, SP). Por fim, discos de oxido de alumínio (SofLex Pop-On, 3M-ESPE) de granulação fina e extrafina serão utilizados para recontorno e polimento final (Deliberador et al., 2012). As LCNC do grupo RI serão reabilitadas utilizando restaurações indiretas em cerâmica Os

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dentes serão moldados em dupla-etapa utilizando material a base de silicone por condensação (Silon 2, Dentisply, USA) e após 1 hora, os moldes foram vazados com gesso tipo IV (Durone, Dentisply, USA). As restaurações em cerâmica serão confeccionadas com cerâmica reforçada por leucita (IPS Empress, Ivoclar-Vivadent, Liechtenstein) e fixadas com cimento resinoso de dupla ativação (Rely X ARC, 3MEspe, St Paul, USA).
1.4 - Protocolo cirúrgico: Serão realizadas as cirurgias periodontais para recobrimento radicular dos grupos, Controle, RD e RI de LCNC já tratados de acordo com o protocolo restaurador. Será realizado enxerto de tecido conjuntivo associado ao reposicionamento coronal do retalho, com incisões do tipo envelope, minimamente invasivo e esteticamente previsível. A área doadora de escolha para obtenção do tecido conjuntivo será o palato na região entre pré-molares e molares, o mesmo será então posicionado na área receptora após obtenção de retalho de espessura parcial e suturado aos tecidos adjacentes de modo a garantir sua imobilidade (Lindhe 2005)."

Amostra: 24 sujeitos de pesquisa;
Financiamento próprio;
Apresenta prontuário de acompanhamento clínico, Apresenta TCLE.
Informa: "A quantidade mínima de cada tipo de tratamento a ser executado: restauração em resina composta e restauração em cerâmica foi determinada após análise de um especialista em estatística para que os resultados do trabalho tenham validade e poder estatístico, conforme documento em anexo."

Considerações sobre os Termos de apresentação obrigatória:
Apresenta: folha de rosto, declaração da instituição co-participante, carta do pesquisador responsável para a faculdade de odontologia-FOUFU, termo de compromisso da equipe executora de acordo com a Resolução nº 466/12.

Recomendações:
Não há.

Conclusões ou Pendências e Lista de Inadequações:
Atendeu a pendência apontada no parecer 332.108.

De acordo com as atribuições definidas na Resolução CNS 466/12, o CEP manifesta-se pela aprovação do protocolo de pesquisa proposto.

O protocolo não apresenta problemas de ética nas condutas de pesquisa com seres humanos, nos limites da redação e da metodologia apresentadas.

Situação do Parecer:
Aprovado

Necessita Apreciação da CONEP:
Não

Considerações Finais a critério do CEP:
Data para entrega de Relatório Parcial ao CEP/UFU: abril de 2014.
Data para entrega de Relatório Parcial ao CEP/UFU: abril de 2015.
Data para entrega de Relatório Final ao CEP/UFU: abril de 2016.

OBS.: O CEP/UFU LEMBRA QUE QUALQUER MUDANÇA NO PROTOCOLO DEVE SER INFORMADA IMEDIATAMENTE AO CEP PARA FINS DE ANÁLISE E APROVAÇÃO DA MESMA.

O CEP/UFU lembra que:
a- segundo a Resolução 466/12, o pesquisador deverá arquivar por 5 anos o relatório da pesquisa e os Termos de Consentimento Livre e Esclarecido, assinados pelo sujeito de pesquisa.
b- poderá, por escolha aleatória, visitar o pesquisador para conferência do relatório e documentação pertinente ao projeto.
c- a aprovação do protocolo de pesquisa pelo CEP/UFU dá-se em decorrência do atendimento a Resolução 466/12/CNS, não implicando na qualidade científica do mesmo.

Orientações ao pesquisador :
¿ O sujeito da pesquisa tem a liberdade de recusar-se a participar ou de retirar seu consentimento em qualquer fase da pesquisa, sem penalização alguma e sem prejuízo ao seu cuidado (Res. CNS 466/12) e deve receber uma cópia do Termo de Consentimento Livre e Esclarecido, na íntegra, por ele assinado.
¿ O pesquisador deve desenvolver a pesquisa conforme delineada no protocolo aprovado e descontinuar o estudo somente após análise das razões da descontinuidade pelo CEP que o aprovou (Res. CNS), aguardando seu parecer, exceto quando perceber risco ou dano não previsto ao sujeito participante ou quando constatar a superioridade de regime oferecido a um dos grupos

da pesquisa que requeiram ação imediata.
¿ O CEP deve ser informado de todos os efeitos adversos ou fatos relevantes que alterem o curso normal do estudo (Res. CNS). É papel de o pesquisador assegurar medidas imediatas adequadas frente a evento adverso grave ocorrido (mesmo que tenha sido em outro centro) e enviar notificação ao CEP e à Agência Nacional de Vigilância Sanitária ¿ ANVISA ¿ junto com seu posicionamento.
¿ Eventuais modificações ou emendas ao protocolo devem ser apresentadas ao CEP de forma clara e sucinta, identificando a parte do protocolo a ser modificada e suas justificativas. Em caso de projetos do Grupo I ou II apresentados anteriormente à ANVISA, o pesquisador ou patrocinador deve enviá-las também à mesma, junto com o parecer aprobatório do CEP, para serem juntadas ao protocolo inicial (Res.251/97, item III.2.e). O prazo para entrega de relatório é de 120 dias após o término da execução prevista no cronograma do projeto, conforme norma.

UBERLANDIA, 30 de Agosto de 2013

Assinador por:
Sandra Terezinha de Farias Furtado
(Coordenador)

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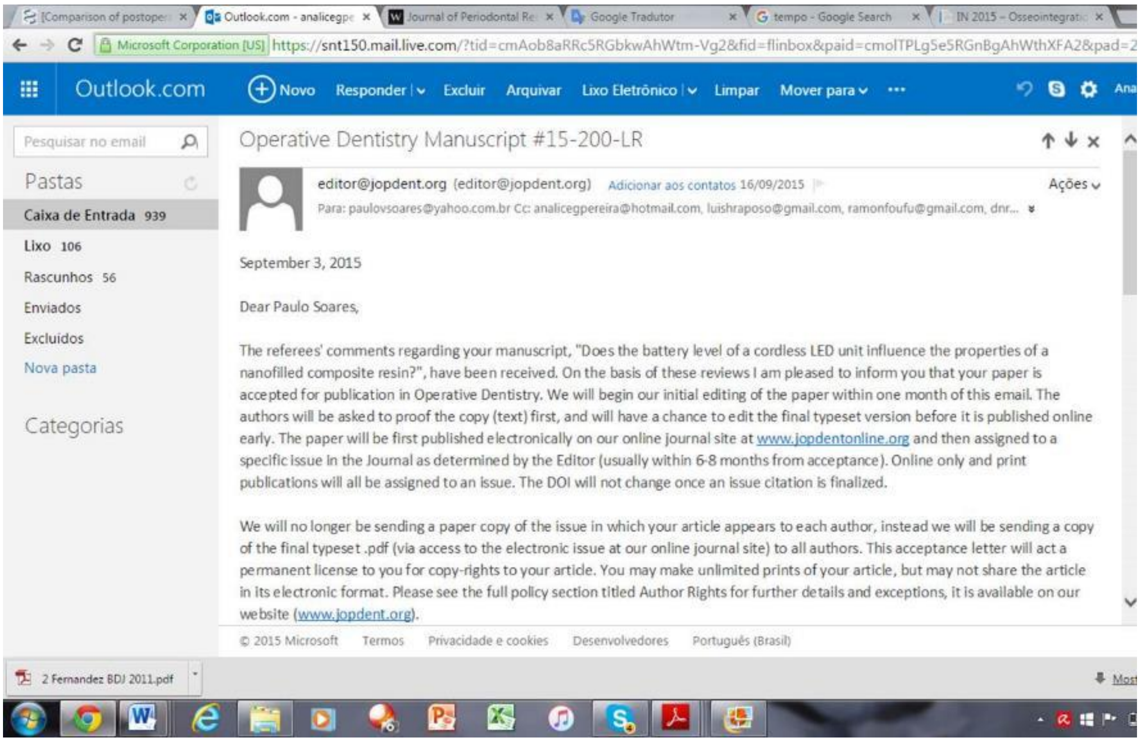
Anexo 3



Operative Dentistry Manuscript #15-200-LR

editor@jopdent.org (editor@jopdent.org) 16/09/2015

Para: paulovsoares@yahoo.com.br Cc: analicegpereira@hotmail.com, luishraposo@gmail.com, ramonfoufu@gmail.com, dnr...

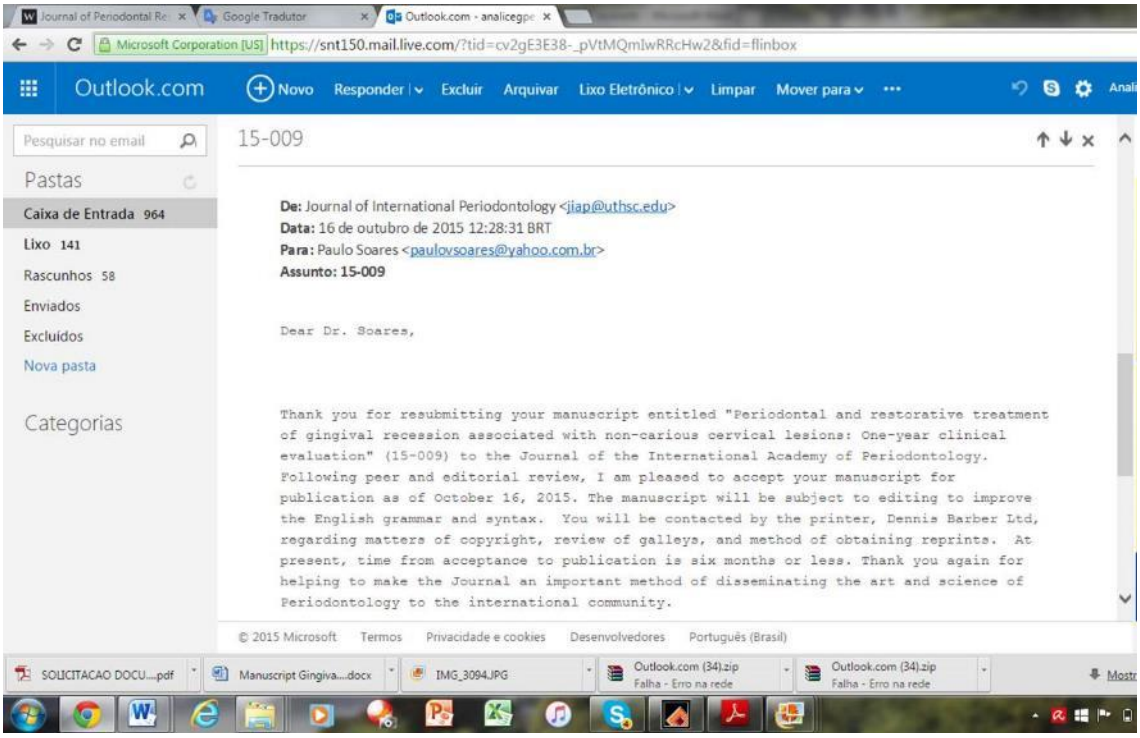
September 3, 2015

Dear Paulo Soares,

The referees' comments regarding your manuscript, "Does the battery level of a cordless LED unit influence the properties of a nanofilled composite resin?", have been received. On the basis of these reviews I am pleased to inform you that your paper is accepted for publication in Operative Dentistry. We will begin our initial editing of the paper within one month of this email. The authors will be asked to proof the copy (text) first, and will have a chance to edit the final typeset version before it is published online early. The paper will be first published electronically on our online journal site at www.jopdentonline.org and then assigned to a specific issue in the Journal as determined by the Editor (usually within 6-8 months from acceptance). Online only and print publications will all be assigned to an issue. The DOI will not change once an issue citation is finalized.

We will no longer be sending a paper copy of the issue in which your article appears to each author, instead we will be sending a copy of the final typeset .pdf (via access to the electronic issue at our online journal site) to all authors. This acceptance letter will act a permanent license to you for copy-rights to your article. You may make unlimited prints of your article, but may not share the article in its electronic format. Please see the full policy section titled Author Rights for further details and exceptions, it is available on our website (www.jopdent.org).

Anexo 4



15-009

De: Journal of International Periodontology <jiap@uthsc.edu>
Data: 16 de outubro de 2015 12:28:31 BRT
Para: Paulo Soares <paulovsoares@yahoo.com.br>
Assunto: 15-009

Dear Dr. Soares,

Thank you for resubmitting your manuscript entitled "Periodontal and restorative treatment of gingival recession associated with non-carious cervical lesions: One-year clinical evaluation" (15-009) to the Journal of the International Academy of Periodontology. Following peer and editorial review, I am pleased to accept your manuscript for publication as of October 16, 2015. The manuscript will be subject to editing to improve the English grammar and syntax. You will be contacted by the printer, Dennis Barber Ltd, regarding matters of copyright, review of galleys, and method of obtaining reprints. At present, time from acceptance to publication is six months or less. Thank you again for helping to make the Journal an important method of disseminating the art and science of Periodontology to the international community.