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| CLINICAL

A clinical evaluation of zirconia reinforced lithium silicate glass-ceramic CAD/CAM onlay: a two-year case report

Avaliação clínica de onlay cerâmica do tipo CAD / CAM de silicato de lítio reforçado com zircônia: um relato de caso de dois anos

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ABSTRACT

The CAD/CAM technology arose from the need to develop materials with better mechanical and optical properties that could be used for making monolithic restorations. Several materials have been used for milling indirect restorations in prefabricated blocks. Among them, lithium silicate reinforced with zirconia. Due to its recent introduction in the market, this case report aimed to present a detailed clinical protocol for the execution of a ceramic onlay of this material using CAD/CAM technology. A 57-year-old female patient sought care with extensive restoration in composite resin (BOMD) of tooth 15 maintained for almost two years. However, due to bruxism, constant dental tightening, the extension of the direct restoration and the need for improved esthetics, it was proposed to replace it with an indirect ceramic onlay restoration. Prophylaxis and choice of the color of the patient's dental substrate were performed. Afterwards, the dental preparation was made and polished. Subsequently, the molding was made with addition silicone and the provisional restoration confectioned. Once the stone model was obtained, it was scanned and the ceramic onlay restoration was milled using CAD/CAM technology. Finally, the restoration was stained and cemented over the preparation. After 2 years, the restoration remained stable, with no evidence of color mismatch, marginal discoloration, marginal cleft, caries or fracture, proving the effectiveness of the treatment in this time interval. The correct indication of the ceramic material combined with the use of CAD/CAM technology facilitated the restorative process, restoring function and the esthetics desired by the patient.

Indexing terms: Ceramics. Computer-aided design. Dental restoration, permanent. Esthetics, dental. Inlays.

RESUMO

A tecnologia CAD/CAM surgiu da necessidade de desenvolvimento de materiais com melhores propriedades mecânicas e ópticas que pudessem ser utilizados para confecção de restaurações monolíticas. Diversos materiais têm sido utilizados para fresagem de

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restaurações indiretas em blocos pré-fabricados. Dentre eles, o silicato de lítio reforçado com zircônia. Devido a sua recente introdução no mercado, este relato de caso objetivou apresentar um protocolo clínico detalhado para a execução de uma onlay cerâmica desse material utilizando a tecnologia CAD/CAM. Paciente, 57 anos, sexo feminino, procurou atendimento com extensa restauração em resina composta envolvendo as faces (MODV) do dente 15 mantida por quase dois anos. Contudo, em virtude do bruxismo, do apertamento dental constante, da extensão da restauração direta e da necessidade de melhora na estética, foi proposto a substituição por uma restauração indireta em cerâmica do tipo onlay. Foi realizada a profilaxia e escolha da cor do substrato dental da paciente. Em seguida o preparo dental foi confeccionado e polido. Posteriormente foi feita a moldagem com silicone de adição e a confecção do provisório. Com a obtenção do modelo, este foi escaneado e fresada a onlay cerâmica pela tecnologia CAD/CAM, que posteriormente foi maquiada e cimentada sobre o preparo. Após 2 anos, a restauração permaneceu estável, sem evidência de incompatibilidade de cor, descoloração marginal, fenda marginal, cárie ou fratura, comprovando a eficácia do tratamento neste intervalo de tempo. A correta indicação do material cerâmico aliada ao uso da tecnologia CAD-CAM facilitou o processo restaurador devolvendo função e a estética desejada pela paciente.

Termos de indexação: *Cerâmica. Desenho assistido por computador. Restauração dentária permanente. Estética dentária. Restaurações intracoronárias.*

INTRODUCTION

Dental ceramics are the main materials used for indirect restorations [1]. However, their application and method of confection has undergone several changes over the last 30 years [2]. Due to their fragility, the first ceramic crowns were applied to metals so that they could resist occlusal forces, which resulted in an artificial appearance of the restoration, limiting its use in areas of esthetic region [2]. Also, around 70% of dental tissue needed to be removed to reach a minimum thickness of each material [3], and these restorations often suffered from chipping, fracture, or delamination of the veneer porcelain due to differences in their properties compared with the material used for infrastructure [4]. Given this, the increased search for esthetics by patients and the valuation of minimal intervention dentistry demonstrated the need to produce ceramic materials with better mechanical properties [5].

The CAD/CAM technology emerged within this context [6]. Computer-Aided Design (CAD) consists of the possibility of digitizing the prosthetic preparation and creating a virtual model in which the restoration can be planned, while Computer-Aided Manufacturing (CAM) produces the piece using data provided by CAD [7]. Both systems can be used in laboratories and dental offices [5]. Partial indirect restorations (such as inlays, onlays, and ceramic veneers), full crowns, fixed partial dentures, implant abutments, among others, are milled by CAM from monolithic blocks [5]. Consequently, these restorations eliminate problems related to the union between layers and have better properties than hand-built restoration restorations using conventional techniques such as firing, pressing, and casting, which tend to incorporate pores and flaws within the material [8,9]. Since CAD is highly accurate in electronic impressions, it reduces costs with consumables materials and eliminates several steps of the traditional process of prosthetic preparation [10]. Thus, CAD/CAM technology opened a new era in restorative dentistry, increasing the use of all-ceramic restorations in a more conservative, fast, predictable, comfortable, and long-lasting way [2,10].

Several materials have been used for milling indirect restorations in prefabricated monolithic blocks. Options include feldspathic, leucite-reinforced porcelains, lithium disilicate, zirconia-reinforced lithium silicate, and composite resin [11]. Zirconia reinforced lithium silicate (ZLS) was launched on the market in mid-2013 by the companies VITA Zahnfabrick (Vita Suprinity) and Dentisply-Sirona (Celtra Press and Celtra Duo). According to the manufacturers, these ceramics are basically composed of a glassy matrix containing a homogeneous crystalline structure of lithium silicate reinforced by zirconia particles [9,12]. Due to this hybrid composition, ZLS combines the positive mechanical characteristics of zirconia with the esthetic appearance of glass ceramics, being usable for either partial or total restorations for anterior and posterior teeth [13]. However, evidence on its use and implications is scarce due to its recent introduction in the market, making both laboratory and clinical studies necessary [12,13].

Therefore, this case report aimed to present a detailed clinical protocol for the execution of a ceramic onlay of this material using CAD/CAM technology.

CASE REPORT

A 57-year-old female patient sought care at the FOP - UNICAMP postgraduate dental restoration clinic with an atypical restoration in composite resin in element 15, which was maintained for almost 2 years (figure 1A). The radiographic examination (figure 1B and 1C) showed no evidence of caries recurrence or injury to the dentin-pulp complex.

However, as can be seen in the intraoral photographs (figure 1D and 1E), it was a very extensive restoration, involving the buccal, occlusal, mesial and distal surfaces threatened by constant dental clenching reported by the patient. The restoration was also stained, which bothered the patient since her smile shows this tooth. Thus, considering the need for aesthetic improvement and reinforcement of the remaining dental structure, it was proposed to replace it with an indirect restoration in ceramic onlay type.

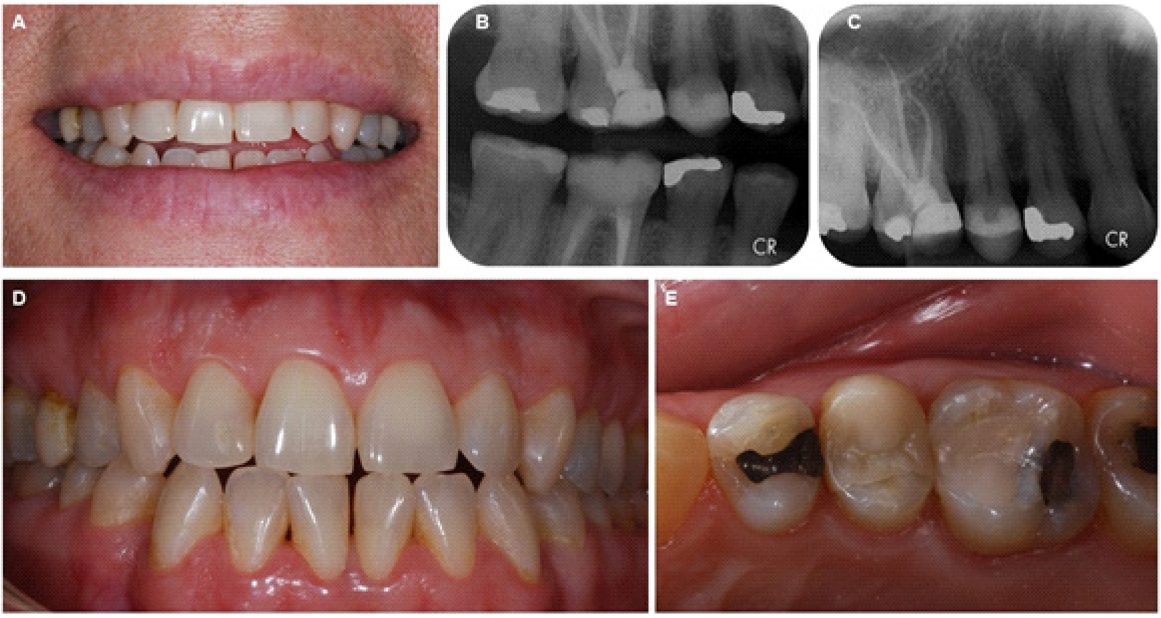

Figure 1. A: Initial appearance; B and C: Interproximal and periapical radiographs, respectively; D: Intraoral photography; E: View through occlusal.

In the first clinical session, a partial impression was performed using heavy addition silicone (Aquasil Easy Mix Putty, Dentsply Sirona, Bensheim, HE, Germany) for subsequent making of a provisional restoration (figure 2A).

Then, the tooth was prepared using KG dental diamond burs (# 3131, 3227, and 2200, KG Sorensen, Cotia, SP, Brazil) (figure 2B and 2C), so that the final shape had the ideal characteristics to receive an indirect restoration, these being: expulsive shape, well-rounded internal angles, well-defined margins, adequate thickness for the ceramic and absence of remaining fragile areas (figure 2D).

After the preparation, the color for making the ceramic onlay was chosen using the VITAPAN® Classical visual scale (VitaZähnfabrik, Bad Säckingen, BW, Germany). The first premolar was used as a reference. As can be seen in intraoral photograph, the ideal color chosen was A3 (figure 2E).

A provisional restoration in autopolymerized acrylic resin (Jet and Dencôr – Artigos Odontológicos Clássicos Ltda., São Paulo, SP, Brazil) was then confectioned using the mold obtained by the previous molding technique performed prior to preparation. This technique was chosen since the restoration at the beginning of the treatment had adequate anatomy, despite its poor esthetic appearance. Thus, with the prior molding technique, it was possible to make the provisional with greater ease and speed (figure 2F). The provisional restoration test was carried out, followed by finishing and polishing. Tooth preparation was also refined with fine and extra fine-grained diamond burs (# 3131 F and FF, 3227 F and FF, KG Sorensen, Cotia, SP, Brazil) in the same formats used for the preparation. Tooth polishing was also carried out with abrasive rubbers of different granulations (Composite Polishing Fast Kit, Microdont, São Paulo, SP, Brazil) (figures 3A and 3B), followed by a felt disc (Diamond Flex, FGM, Joinville, SC, Brazil) with diamond paste (Diamond Excel, FGM, Joinville, SC, Brazil) (figure 3C).

After the refinement and polishing of the preparation, the final impression was made. For this procedure, two gingival retracting cords (UltraPak, Ultradent Products, Cologne, NRW, Germany) of different thicknesses were placed. The thinner wire (#000) was inserted completely and more deeply in the gingival sulcus, to initiate the removal, protect

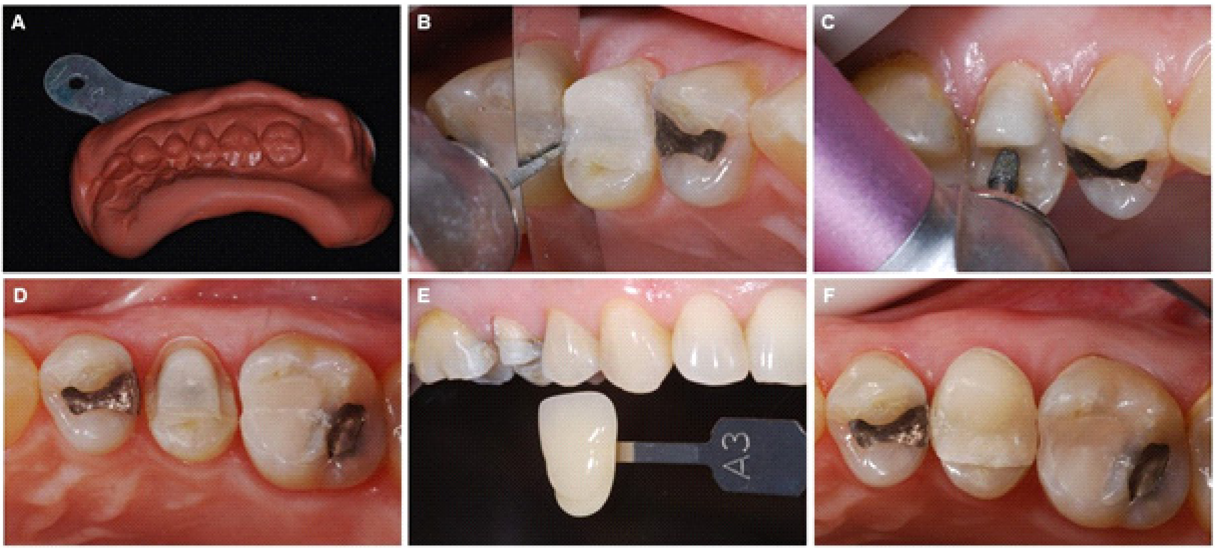

Figure 2. A: Previous molding; B and C: Tooth preparation for onlay using diamond tips; D: Final appearance of the preparation; E: Choice of ceramic color with VITA scale; F: Temporary restoration in acrylic resin.

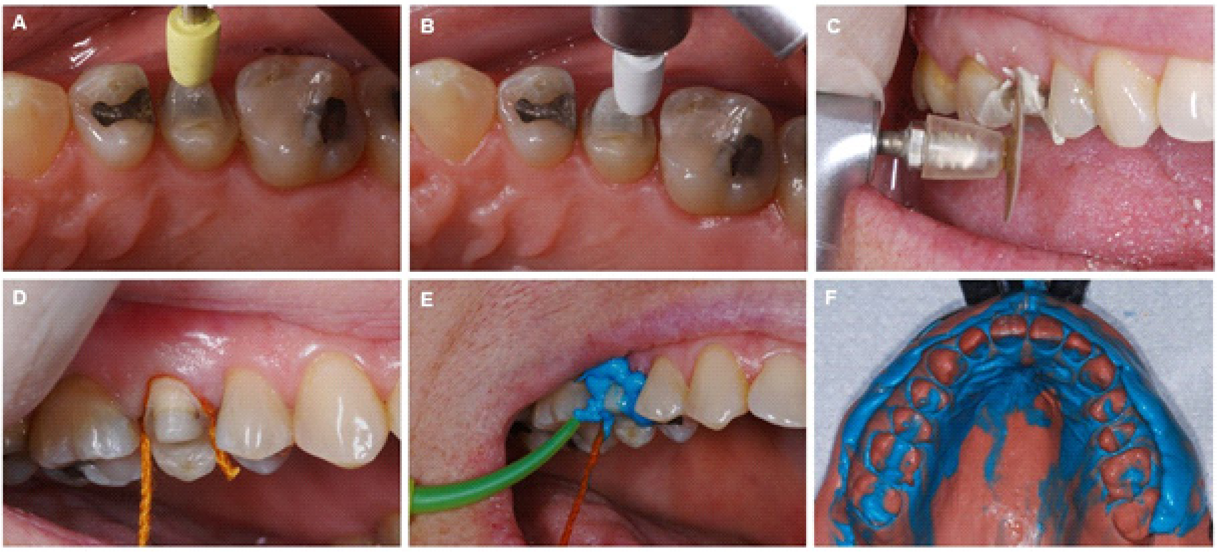

Figure 3. A and B: Polishing the tooth preparation with abrasive rubbers of different granulations; C: Polishing with a felt disc and diamond paste; D: Insertion of retracting cords; E and F: Double mix molding.

the biological space, and control the crevicular fluid, while the thicker wire (#0) was inserted immediately afterwards, pushing the gingival tissue laterally, so that half of its thickness was outside the groove (figure 3D). The technique of double mixing using addition silicone material (Aquasil Easy Mix Putty, Dentsply Sirona, Bensheim, HE, Germany) was used for the final impression. In this technique, the most superficial retracting wire is removed simultaneously with the application of low viscosity silicone (figures 3E and 3F), and the thinner wire is removed from the groove at the end of the impression process. After that,the molds obtained were poured with Type IV dental stone (Durone IV, Dentsply Sirona, Petrópolis, RJ, Brazil).

Between the first and second clinical sessions, the ceramic onlay was fabricated using the CAD/CAM technology (InLab MC XL, Sirona Dental Systems GmbH, Bensheim, HE, Germany) in a single laboratory step. For this, the stone model obtained by final impression was scanned and the technician used a software (InLab 15.0, Sirona Dental Systems GmbH, Bensheim, HE, Germany) to design the onlay contours and occlusal relationships virtually (figure 4A). The ceramic onlay was then milled from a block of zirconia-reinforced lithium silicate (Celtra Duo - BL2, Dentsply Sirona Restorative, Konstanz, BW, Germany) in a wet griding process at standard miling speed (figure 4B). After recovering the onlay from the miling chamber, the technician cleaned the onlay with a steam cleaner, and applied a paste (Universal Stain Kit, Dentsply Sirona, Konstanz, BW, Germany) with stains to customize its shade accordingly. The onlay was fired in a porcelain oven under vacuum according to the manufacturer's instructions. The glaze firing cycle consisted of two stages (1st 820°C, 2nd 810°C, heating rate 55°C/min, hold time 30 min) to increase the flexural strength of Celtra Duo to 370 MPa and accentuate the onlay' shade.

In the final clinical session, the provisional restoration was removed, and the preparation was cleaned with flour of pumice. The onlay restoration was tested on the patient and had an excellent adaptation to the preparation requiring only minor occlusal contacts adjustments performed with fine diamond burs (#1190 F, KG Sorensen, Cotia, SP, Brazil) under water-cooling (figure 4C).

After that, to ensure an appropriate cementation, both surfaces of the ceramic onlay and the tooth were treated. Hydrofluoric acid (HF) 10% (Dentsply Sirona, Petrópolis, RJ, Brazil) was applied on the internal surface of the onlay for 20 seconds (figure 4D), rinsed with water and air-dried with oil-free air (figure 4E). Then, two thin layers of the primer / activator silane mixture (Silano Mais, Dentsply Sirona, Petrópolis, RJ, Brazil) in a proportion of 1:1 was applied and left for rest for at least 60 seconds to ensure evaporation of the solvent before adhesive cementation (figure 4F). To treat the tooth surface, phosphoric acid 37% (Dentsply Sirona, Petrópolis, RJ, Brazil) was applied on enamel for 30 seconds, rinsed

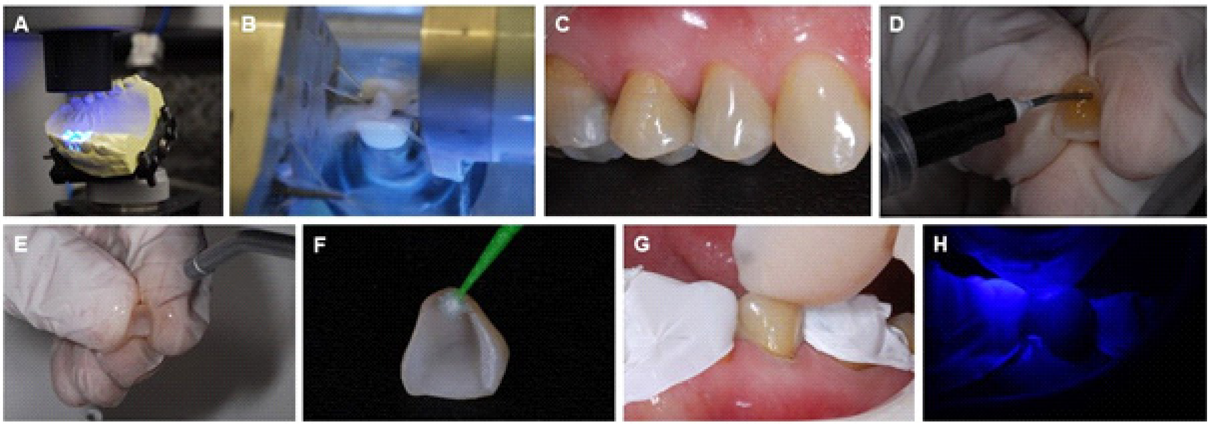

Figure 4. A: Scanning of the stone model; B: Ceramic onlay milling; C: Proof of the onlay in the mouth; D: Conditioning the onlay with HF; E: Water wash; F: Silane application; G: Onlay cementation; H: Cement light-activation.

with water and air-dried. The adhesive system used was the Prime&Bond Universal (Dentsply Sirona, Petrópolis, RJ, Brazil), which was vigorously applied onto the tooth surface, as recommended by the manufacturer, without precuring. Soon after, the dual cure resin cement (Calibra Ceram, Dentsply Sirona, Petrópolis, RJ, Brazil) was applied to the internal surface of the ceramic onlay, which was then positioned over the preparation (figure 4G). An initial light curing was made using a LED curing unit (Radii-Cal, SDI, Basywater, VIC, Australia) set to an irradiance of 1200mW/cm2 for 5 seconds (figure 4H). This light curing allows the removal of excess cement with ease without losing stability of the piece in position. After removing the excesses, a final light curing was carried out for another 40 seconds on each face of the indirect restoration. After cementation (figure 5A), small occlusal adjustments were made using extra fine-grained diamond tips (#1190 FF, KG Sorensen, Cotia, SP, Brazil), and polishing with abrasive rubbers for ceramics of different granulations (Pontas Exa-Cerapol PM – Edenta AG, Au, ZRH, Switzerland), followed by brushes with fibers impregnated with silicon carbide abrasive particles (OptiShine, Kerr, Bioggio, TI, Switzerland) (figure 5B).

Figure 5. A: Occlusal view after cementation; B: Polishing rubbers; C: Extraoral photograph after immediate completion of treatment.

The indication and correct use of a ceramic material combined with the use of CAD/CAM technology greatly facilitated the restorative process and recovered the function and the esthetic desired by the patient (figure 5C).

Two years later, the patient returned to the clinic for a follow-up. The clinical evaluation was performed by two independent evaluators using modified U.S. Public Health Service (USPHS) criteria [14] for color match, margin discoloration, margin adaptation, caries and onlay fracture. The two evaluators discussed disagreements in evaluation to reach a consensus judgment for each criterion evaluated. The onlay restoration remained stable, with no evidence of color mismatch, margin discoloration, creviche along the margin, caries or onlay fracture, proving the effectiveness of the treatment in this time interval (figures 6A and 6B).

The patient signed an Informed Consent Form, so her images and other clinical information were reported in the journal.

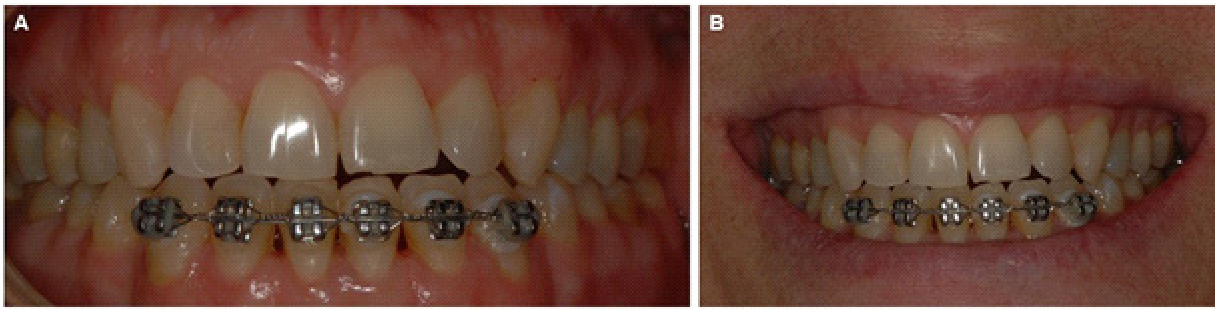

Figure 6. A and B: Two years follow-up after treatment.

DISCUSSION

Advances in the adhesive area and in the development of materials with better properties have enabled the implementation of more conservative restorative techniques [10]. Onlay restorations are defined as any partial ceramic restoration that covers at least one cusp [1]. Whenever possible, the indication of this type of restoration is more desirable than full crowns. According to Edelhoff et al., partial restorations present a lower risk of damage to the pulp, better protection of hard tissues, easier molding, better visualization of the site during preparation and adhesive cementation, less interference with the marginal gingiva, among others [3]. Furthermore, the literature shows that vital teeth have a more favorable outcome on the longevity of onlay restorations and are less likely to fail than non-vital teeth [1]. Thus, to perform a minimally invasive treatment of element 15 and optimize the restorative procedure, the replacement of the deficient direct restoration in resin composite for a ceramic onlay with protection of the buccal cusp was indicated.

The material chosen for milling the onaly restoration was ZLS, Celtra Duo by Dentsply. Despite the lack of strong evidence based on randomized controlled clinical studies of the long-term clinical performance of this material, ZLS restorations have shown fracture resistance values exceeding the physiological occlusal/masticatory forces in in vitro studies and higher to bilaminate restorations [15]. Furthermore, this material has demonstrated a certain ability to interrupt the propagation of cracks that can contribute to an increase in its survival rate due to the presence of tetragonal zirconia particles (10% by weight) that change phase and interrupt the fracture line close to its origin [16]. Regarding aesthetics, ZLS is also more translucent than other materials, including lithium disilicate (LiSO2) - one of the main ceramics used for anterior teeth due to its excellent optical properties [6,17]. This has been attributed to its homogeneous glassy matrix composed of small particles (0.5 – 1μm), around 6 times smaller than those of LiSO2, which allow a better light passage and improve the final appearance of the restoration [8, 18]. Sorrentine et al. in a recent narrative review stated that the optical and mechanical properties of ZLS allow its use for single-unit restorations, either for partial or full coverage, tooth- or implant-supported, in both anterior and posterior regions, as well as for table-tops [6]. In agreement with these findings, the ZLS presented itself as a viable option for the fabrication of partial restoration through CAD/CAM technology in an area that needs both mechanical resistance and a good aesthetic result, such as superior premolars in this case report.

According to the manufacturers, the prefabricated blocks of this material are fully sintered and can be found in several colors [19]. The shade for milling the ceramic onlay restoration used was BL2. Since it is a white block, performing the extrinsic characterization of the restoration was necessary to mimic the color of the patient's adjacent teeth. After that, the restoration needed to be submitted to a firing protocol. According to the literature, this additional firing is especially indicated for restorations of posterior teeth made from ZLS, since it increases the crystalline phases of the material and consequently its mechanical properties [6,14,20]. Moreover, it also contributes to better color stability over time [21]. However, it should be noted that extrinsic characterization is a process that requires a lot of manual dexterity from the prosthetic to obtain a satisfactory esthetic result, and since it is an additional laboratory step, it can prolong the total time of the restorative treatment [22].

Regarding the cementation protocol, considering that ZLS is composed of a glassy silica matrix, etching with HF followed by application of the silane primer represents the gold standard for the surface treatment of this material. HF promotes micromechanical retention by dissolving of the glass matrix while silane ensures a chemical interaction of resin-based agents to ZLS [20]. However, different etching duration and acid concentration values have been suggested without reaching a consensus on an appropriate acid etching protocol [6]. In tooth preparation, selective acid etching in enamel and the use of conventional or universal adhesive systems are preferable to self-etching adhesive systems to avoid marginal discoloration and loss of adhesion, especially in minimally invasive preparations [6]. Due to the high translucency of ZLS, both resinous and dual cements can be used [6].

According to systematic reviews, the most frequent cause of failure of ceramic restorations is fracture [1,23]. Even after 2 years, the onlay restoration did not fail and maintained color stable. This result can be attributed not only to the correct indication of the material and the proper execution of the restorative protocol, but also to the technique used for restoration confection. Monolithic blocks are produced by highly controlled industrial techniques, which reduce the presence of flaws and pores [9]. The CAD software, in turn, identifies the areas that need greater thickness according to the intermaxillary relationships between the digitized upper and lower models [5]. Consequently, restorations made by CAD/CAM technology have shown better structural quality, high accuracy, and efficiency [5, 10]. The literature has demonstrated good fracture resistance of ZLS restorations at a thickness of 1mm [6]. Using CAD software, it was possible to plan the dimensions of the onlay so it can resist occlusal forces, and this may have contributed to its survival rate after 2 years. Despite the small number of clinical studies performed to evaluate the clinical success and survival rates of ZLS, the result of this case report is in agreement with Zimmermann et al., who found that ZLS-based restorations onto the posterior tooth, for inlays or partial crowns, showed a high clinical success rate (96.7%) after 1 year of clinical service [24].

Another advantage of the CAD/CAM technology is the versatility of the workflow that can be fully digital or partial. In the fully digital flow, both the digitalization of the preparation, the planning and production of the restoration are carried out in the office and the patient is rehabilitated in a single session [22]. However, the dentist needs to purchase a CAD/CAM system in the office to make this possible, which is still quite expensive, and the operator needs to spend time and money on training. Dentists may have difficulty making the investment worthwhile without a sufficient volume of restorations [5]. The viable alternative is to adopt the partial workflow, as demonstrated in this case report. Conventional impression was performed, the mold was immediately cast, and the produced stone models were digitized in the laboratory. There, the CAD/CAM technology was used to design and mill the restoration, which later underwent esthetic characterization. With this, it was possible to use several benefits that the CAD/CAM technology provides, such as the quality of the piece fabricated from monolithic blocks of ZLS, without the need to make a high investment, and in a fast treatment comprising of only two clinical sessions. However, more long-term clinical studies are needed to validate the positive outcome of this two-year clinical experience.

CONCLUSION

The association of partial digital flow and the indication of ZLS as the material of choice for the onlay confection was effective to restore an area that needs both mechanical resistance and a good esthetic result, such as upper premolars. Thus, providing self-esteem to the patient and returning the shape, function, and esthetics of the tooth in a predictable, safe, and conservative way.

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Collaborators

JFL Marques Conceptualization, Writing - original draft preparation, Investigation, Methodology, Review and Editing. DF Sobral-Souza: Conceptualization, Writing - original draft preparation, Writing - Review and Editing. GM Marchi, DANL Lima and FHB Aguiar, Conceptualization, resources, writing - review & editing, supervision.

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