Hybrid ceramics and universal luting agents for posterior adhesive partial restorations: a clinical case

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Thanks to the improvements in restorative materials and adhesive techniques and due to the increasing demand of patients for aesthetics, the use of partial coverage restorations has dramatically increased over the last years.[1] Indirect partial restorations enable a minimally invasive approach, maintaining a significant amount of tooth structures and contributing to the strengthening of teeth compromised by caries and/or fractures, creating an adhesive monoblock between dental tissues and restorative materials.[2]

Posterior partial restorations are classified as inlays (without cusp covering), onlays (covering at least 1 cusp) and overlays (covering all cusps); in the case of no-prep occlusal restorations replacing abraded or eroded dental tissues, they are usually referred to as table-tops.[3]

Recent systematic reviews and meta-analyses reported that survival rates of inlays, onlays and overlays are very satisfactory regardless of the restorative material, the type of tooth and the follow-up time (up to 10 years); vital teeth showed longer survival than endodontically treated ones, the margins of onlays performed better than those of inlays and the most frequent cause of failure was fracture.[1,4]

Currently, several resin and ceramic materials are available for the fabrication of partial coverage restorations; similarly, different manufacturing techniques can be used, as Computer-aided design/Computer-aided manufacturing (CAD/CAM), heat-pressing and layering techniques.[5] Several issues have to be carefully considered when selecting the restorative material: thickness, dental substrate, occlusal loads, mechanical strength, optical properties and adhesive potential.

Glassy materials (i.e. feldspathic, leucite-reinforced, lithium disilicate-based ceramics) excel at optical and adhesive properties but show intrinsic brittleness, whereas polycrystalline cores (i.e. zirconia) present an utmost mechanical resistance but are more opaque and show lower values of pure bond strength.[5] In order to combine the advantages of resin and ceramic materials and improve the wear behaviour of ceramic restorations, hybrid ceramics have been developed, also known as resin matrix ceramics (RMC).

RMC materials show higher elastic modulus than resin composites, higher fracture toughness than enamel, moderate wear resistance, advantageous milling properties and better damage

tolerance than glass ceramics. They consist of ceramic crystals embedded into a three-dimensional polymer matrix to provide intermediate mechanical properties between ceramics and resins. RMC can be effectively bonded onto dental tissues; as to surface treatment, according to the prevalence of the ceramic or the resin content, RMC can be conditioned by acid etching or sandblasting, respectively.[6,7]

One of the smartest representatives of these innovative hybrid materials is CERASMART270 (GC), characterized by physical properties very similar to those of natural enamel and highly wear resistant. It is fabricated as CAD/CAM blocks and shows very easy machinability and reduced working time since no sintering or crystallisation is needed after milling. Its surface can easily be stained and characterised by dental technicians in the laboratory or by dentists directly chairside with OPTIGLAZE color (GC). Moreover, although the material is quite insensitive to chipping, it can be easily repaired or modified intraorally after cementation.

The following case report describes the clinical steps for the fabrication of an adhesive overlay on a mandibular molar using CERASMART270.

Case presentation

A referred 34-year old male patient presented with a distal subgingival secondary decay adjacent to an old MOD restoration on a vital tooth 46. The reported chief complaints were tooth sensitivity, gingival bleeding, food impaction and difficult and painful chewing.

The treatment was started with periodontal cleaning and the patient was motivated to maintain proper periodontal health by means of correct home oral hygiene procedures.

Crown lengthening was performed on the distal surface of the tooth to expose a satisfactory amount of sound dental tissues and to guarantee proper access for hygienic maintenance over time.

After removing the old restoration and the infected dental tissue, a core build-up was made with resin composite. The peripheral enamel was treated following the selective enamel etching approach using 37% phosphoric acid etching for 30 seconds, while the clean cavity dentine was conditioned with a cross-linker for 15 seconds; then, all the dental tissues were thoroughly rinsed and dried. A universal bonding agent (G-Premio BOND, GC) was applied onto both enamel and dentine according to the manufacturer's instructions; after that, a second layer of bonding was applied as previously described following the double coating approach, aimed at reducing possible voids and/or bubbles in the adhesive layer and achieve the best bond strength. A thin layer of everX Flow (GC) was applied in the cavity and then light-cured to seal all possible undercuts and strengthen the restorative complex. Subsequently, the core build-up was completed with G-ænial A'CHORD (GC). Shade BW (Bleach White) was used to better identify the transition areas during the overlay preparation (Figure 1). The tooth was prepared in a minimally invasive way to keep as much dental structure as possible: all the internal angles were rounded and an occlusal clearance of 2 mm was prepared to guarantee proper thickness of the overlay (minimum occlusal thickness: 1.5 mm) (Figure 2). The restorative

Fig. 1: Core build-up and overlay preparation.

Fig. 2: Verification of the occlusal clearance to guarantee at least 1.5 mm of thickness for the restoration.

margins were maintained supragingivally: a 0.7 mini-chamfer was designed circumferentially with the only exception of the buccal surface, where a bevelled preparation was made to enhance the aesthetic outcome of the restoration.

An intraoral scanner (IOS) was used to make an optical impression and import the preparation shape and volume in the digital environment of a CAD software where the restoration was designed and carefully checked. The overlay was easily milled in about 12 minutes from a CERASMART270 (GC) CAD/CAM block, which is very gentle towards milling burs: the optimal machinability of the material ensures reduced manufacturing time and reduces costs related to the wear of the milling units. Furthermore,

Fig. 3: 3D-printed master cast.

Fig. 4: Occlusal view of the CERASMART270 overlay on the master cast.

Fig. 5: Buccal view of the CERASMART270 overlay on the master cast.

Fig. 6: Extraoral view of the CERASMART270 overlay: outer surface (left side) and intaglio surface (right side).

fabrication time was even more reduced since CERASMART270 does not need any further sintering and/or crystallisation (Figures 3-6).

Among RMC materials, to date, CERASMART270 is the only one that allows clinicians to condition the ceramic surface with a chemo-mechanical approach, using both 5% hydrofluoric acid etching for 60 seconds and mild sandblasting (50 microns alumina particles at 1 bar). Consequently, before cementation, the outer surface of the restoration was protected with a customised silicone template whilst the intaglio surface was subjected to the abovementioned chemo-mechanical protocol. Then, the conditioned surface was cleaned with a dedicated cleansing solution for 2 minutes, to remove impurities and increase wettability; subsequently, the overlay was dipped in a 96% ethanol solution in an ultrasonic bath for 5 minutes to remove possible ceramic debris and other contaminants. Finally, the intaglio surface was conditioned with G-Multi PRIMER (GC) to enhance the adhesive bond between the hybrid ceramics and the resin luting agent (Figure 7).

Fig. 7: Adhesive protocol and universal luting system used for cementation. The intaglio surface of the restoration was conditioned with G-Multi PRIMER. The tooth surface was treated with an adhesive booster (AEP); alternatively, if a longer working time is needed, a conventional light-curing bonding agent can be tallied onto the tooth.

Fig. 8: The prepared tooth under rubber dam isolation.

Fig. 9: Phosphoric acid etching of dental tissues.

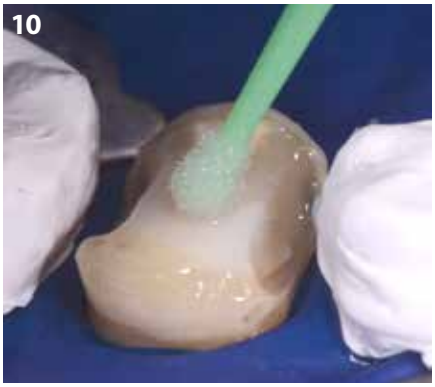

Fig. 10: Application of the adhesive booster (Adhesive Enhancing Primer, AEP), because of low retentive characteristics of the partial preparation.

Fig. 11: Filling the overlay with the universal resin cement (G-CEM ONE).

The operative field was isolated by means of rubber dam and Teflon tapes were placed over the adjacent teeth to prevent any possible entrapment of cement remnants (Figure 8). In order to clean the resin composite core build-up and etch the prepared peripheral enamel, 37% phosphoric acid was applied for 30 seconds (Figure 9); then, the tooth was thoroughly rinsed and dried. The G-CEM ONE Adhesive Enhancing Primer (AEP; GC) was used selectively onto the residual dental tissues as bonding booster to enhance the adhesive luting of the overlay and direct the polymerisation shrinkage towards the abutment tooth (Figure 10). The AEP contains a touch-cure initiator that will secure and accelerate adhesion when in contact with the luting agent; it allows for stronger bonding and faster cement setting but it is worth remembering that this also means shorter working time (particularly important in case of cementation of multiple restorations simultaneously). Alternatively, if a longer working time is desirable, G-Premio BOND can be applied onto the tooth and then light-cured.

The overlay was luted using G-CEM ONE (GC), a universal luting system that can be used both with conventional etch-and-rinse or self-adhesive approaches, according to the clinician's preferences. The intaglio surface was filled with the universal resin cement using an auto-mixing micro-tip that avoids the formation of voids and bubbles within the bulk of luting agent and allows to reach easily even very small areas of restorations and teeth (Figure 11). After seating the overlay with finger pressure and keep it steadily in position, the overflow of the luting agent was tack-cured for 1 seconds, so as to remove all cement excess easily in bulk (Figure 12). The cementation margins were carefully inspected under magnification and cleaned

Fig. 12: Intraoral seating of the restoration, showing the optimal flowability of the luting agent.

Fig. 13: Detail of the occlusal surface showing the staining characterisation done with OPTIGLAZE color.

Fig. 14: Immediate post-cementation view, showing optimal marginal adaptation and shade integration.

with microbrushes, blades and plastic curettes, in order not to scratch the polished surface of the restoration and avoid any possible roughness holding mycobacterial plaque and stains. Each surface of the overlay was light cured for 40 seconds; finally, glycerine gel was applied onto all the cementation margins to avoid any possible inhibition of polymerisation due to oxygen and post-curing was completed for 40 seconds more onto each surface.

The cementation margins were carefully finished and polished with dedicated rubber points, disks and diamond pastes in decreasing grain size (Figure 13). Subsequently, the rubber dam was removed (Figure 14) and static and dynamic occlusal contacts were carefully checked and adjusted (Figure 15); The adjusted areas were further polished (Figure 16).

Conclusions

The use of adhesive partial coverage restorations has become more and more widespread in the last years particularly onto vital teeth in order to save a significant amount of dental tissues and restore function and aesthetics in a minimally invasive way. The use of a fully digital workflow using intraoral scanning and chairside milling units could be significantly advantageous to reduce working time (possibly completing the restorative treatment in a single appointment) and increases patients' comfort and compliance.

Fig. 15: Occlusal contact areas after occlusal adjustment and polishing.

Fig. 16: Occlusal post-operative view of the overlay.

In such an evolving scenario, hybrid and resin matrix ceramics offer several advantages; particularly, CERASMART270 provides fast and easy machinability, limited working time due to the absence of sintering and/or crystallisation requirements and gentle wear behaviour over time. Moreover, the polymer matrix of RMC materials allows to repair and/or modify restorations directly in the oral cavity, even after cementation or several years of clinical use. This feature could be particularly beneficial in those clinical situations in which operators would like to have further chances over time to retrieve restorations, as in case of heavy acidic oral environment (i.e. gastroesophageal reflux disease - GERD, bulimia, acidic diets, etc.), risk for tooth vitality (easy endodontic access and subsequent repairability) and developing dentition (i.e. young patients, passive eruption, etc.).

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References

1. Naik VB, Jain AK, Rao RD, Naik BD. Comparative evaluation of clinical performance of ceramic and resin inlays, onlays, and overlays: A systematic review and meta analysis. J Conserv Dent 2022;25:347-355.
2. Guess PC, Strub JR, Steinhart N, Wolkewitz M, Stappert CF. All-ceramic partial coverage restorations - Midterm results of a 5-year prospective clinical splitmouth study. J Dent 2009;37:627-637.
3. Veneziani M. Posterior indirect adhesive restorations: Updated indications and the morphology driven preparation technique. Int J Esthet Dent 2017;12:204-230.
4. Dioguardi M, Alovisi M, Troiano G, Caponio CVA, Baldi A, Rocca GT, Comba A, Lo Muzio L, Scotti N. Clinical outcome of bonded partial indirect posterior restorations on vital and non-vital teeth: a systematic review and meta-analysis. Clin Oral Investig 2021;25:6597-6621.
5. Zarone F., Di Mauro M.I., Ausiello P., Ruggiero G., Sorrentino R. Current status on lithium disilicate and zirconia: a narrative review. BMC Oral Health 2019;19:134.
6. Eldafrawy M, Nguyen JF, Mainjot AK, Sadoun MJ. A functionally graded PICN material for biomimetic CDA-CAM blocks. J Dent Res 2018;97:60-67.
7. Moshaverinia A. Review of the modern dental ceramic restorative materials for esthetic dentistry in the minimally invasive age. Dent Clin North Am 2020;64:621-631.