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Fixed Prosthodontics

All-Ceramic Inlay-Retained Fixed Dental Prosthesis: A Case Report

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Abstract **Case Report**

Different restoration options are available for replacing a single missing tooth on the posterior region; full coverage fixed dental prostheses, implant-supported crown and inlay-retained fixed dental prostheses (IRFDPs). In fact, this last achieve an esthetically and functionally good result, and present almost reversible treatment given that, the preparation is conservative preserving dental and gingival tissues. Thus, it can be concluded that all-ceramic inlay retained fixed dental prostheses are an esthetic option that can be recommended as viable short- or middle-term minimally invasive restoration. Case selection, material choice, preparation design and luting procedures are determinant factors of success. This paper aimed to discuss through a case report, the material and the preparation design of all-ceramic inlay-retained fixed dental prostheses.
Keywords: Inlay-retained fixed dental prosthesis, ceramic, aesthetics, minimally invasive.

INTRODUCTION

Several therapeutic options are available for single fixed prosthodontic rehabilitation in posterior region. Implant-supported single crowns can be used without having to sacrifice healthy tooth structure. Nonetheless, many situations may preclude implant therapy, such as medical factors, scarce bone or anatomical constrains, the economic situation or negative attitude of the patient toward surgical treatment [1]. In these cases, an inlay retained fixed dental prosthesis is an appealing minimally invasive treatment modality, that should be proposed, especially on the presence of restorative fillings adjacent to the missing tooth instead of a full coverage restorations. This paper report a clinical case where the treatment was achieved using all ceramic resin-bonded inlay-retained bridge for the replacement of a missing first upper molar.

CASE REPORT

A 35-year-old female patient was referred in our prosthodontic department for the rehabilitation of her upper first molar recently extracted.

The clinical examination revealed proximal provisional restorations adjacent to the missing tooth (fig 1) with a healthy periodontal tissues. The patient oral hygiene was acceptable.

Figure 1: The proximal provisional restorations: (a) The Maxillary second molar; (b) The Maxillary second premolar

After examination of study models, radiographic images and intraoral photographs, various treatment approaches were considered, implant-supported crown, inlay retained fixed dental prostheses and conventional full coverage restoration. The patient desire a fixed pre-implant rehabilitation as a long-term provisional solution and refused completely the removable partial dentures. Thus, a ceramic inlay retained fixed dental prosthesis was proposed since it is the most conservative solution that could be later modified.

After the removal of the old restorations and the excavation of secondary caries, the preparation was performed considering the recommended principles of inlay preparation with a supra-gingival cervical margin on the second premolar and a juxta-gingival cervical position on the second molar (Fig 2) .Before any provisional prosthesis or taking impression, an immediate dentin sealing (IDS) was performed in order to prevent sensitivity, contamination and to promote the adhesion later (Fig 3).

Figure 2: The removal of the provisional restorations and the preparation of the inlay cavities

Figure 3: The light polymerization of the adhesive for the immediate dentin sealing (IDS)

After that, the impression was taken using condensation silicone (Protesil® putty base and catalyst, light base) with the simultaneous double mixing technique and then sent to the laboratory. In advance, gingival retraction cord was used to obtain a better emergence profile. For the mandibular arch, an irreversible hydrocolloid (Cavex CA 37®) was used.

The provisional prosthesis which helped us to visualize the project, to check the preparation design, the absence of undercuts and the stability of the inlays in their cavities (Fig 4), was bonded using an eugenol-free provisional cement (Temp Bond N E) to guarantee the success of the adhesion The conception and the fabrication of the restoration was achieved from CAD-CAM lithium disilicate glass ceramic (Fig 5).

Figure 4: The lateral view of the provisional prosthesis

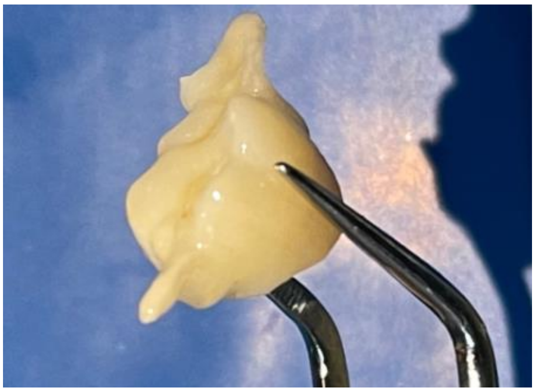

Figure 5: Lithium disilicate glass ceramic inlay-retained fixed dental prosthesis (IRFDPs)

Before cementation, the restoration were evaluated in terms of fit, integrity, marginal adaptation, occlusion and esthetics (Fig 6). The using of try in paste had led to the choice of a transparent dual-cure resin cement color (Variolink®N intro pack).

Figure 6: The evaluation of the marginal adaptation, fit and the shade of the restoration

The restoration's surface was etched with 9% hydrofluoric acid (Porcelain Etch®, Ultradent) for 60 seconds(Fig 7a), washed, dried, and of silane agent was applied (Monobond® N) for 1minute Then, adhesive procedures were performed using a rubber dam before treating the teeth surfaces (Fig 7b).

On the other hand, selective etching was performed on the tooth surface with 37% phosphoric acid (N-Etch®, Ivoclar Vivadent) (Fig 7c), followed by washing with a water and air jet. The adhesive was applied on the tooth using a micro brush and to avoid inaccuracies of fit, it was not light-polymerized (Fig 7d).

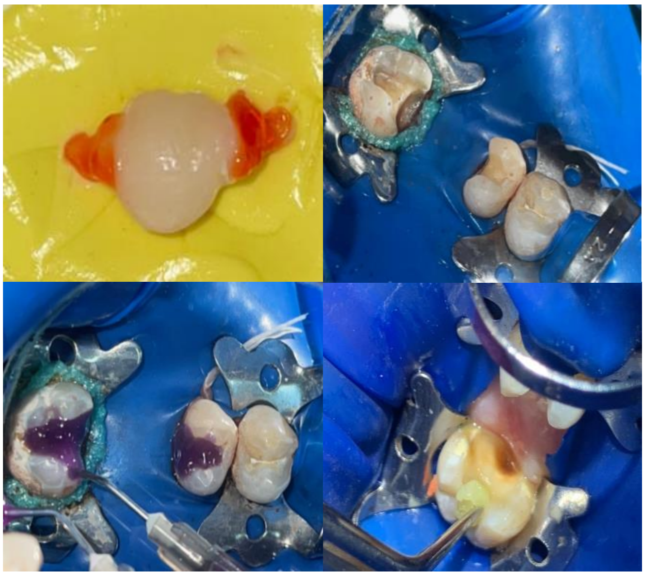

Figure 7: The bonding protocol: a-The surface treatment of the retainers (hydrofluoric acid etching); b-The proper isolation using the rubber dam; c- The treatment of dental surfaces (acid etching with orthophosphoric gel); d- Application of the adhesive

The inlay-retained-fixed dental prosthesis was placed under finger pressure until full seating. A flash light-polymerization (2 seconds) ensured stabilization and a micro brush was used to remove the material excess that was extruded from margins. To prevent the formation of an oxygen inhibited layer, the margins were covered with glycerin gel and the two part of the restoration were light polymerized for 40 seconds each one.

Residual cement excess was further removed with a 15c scalpel. Finally, the static and dynamic occlusion were adjusted (Fig 8) followed by restorations polish.

Figure 8: The occlusion adjustments after bonding

Figure 9: The final restoration

DISCUSSION

Currently, there are many options for posterior single-tooth replacement; implant-supported crown and full coverage crown either metal-ceramic or all-ceramic [2] but inlay-retained fixed dental prostheses have been also proposed, since it became more prevalent with all-ceramic materials meeting the increased aesthetic demands of patients. Inlays are used as retainers and might include existing fillings on adjacent teeth. Minimally invasive procedures based on adhesive approach may offer an alternative to conventional retained full-coverage. It allows greater preservation of pulp and healthy tooth structure and makes periodontal assessment easier [2]. Moreover, it could be a suitable solution when craniofacial growth is still expected given the reversibility of the treatment. Inlay-retained bridges are a good option in patients with good oral hygiene and low susceptibility to caries. Contraindications include severe dental malposition, the absence of sufficient amount of enamel on the preparation margins, extensive crown defects and mobility of abutment-teeth [3].

In the literature, the survival rate of IRFDPs (Inlay-Retained Fixed Dental Prostheses) varies widely from 38% to 95.8% [4] because of the diverse framework materials, tooth preparation designs, and cement bonding techniques. In regards to the material used, mostly authors from the literature reviewed have reported suitable results for zirconia-based CIR-FDPs (Ceramic Inlay Retained-Fixed Dental Prostheses) [5-13] when compared with lithium-disilicate ceramic in terms of fracture resistance [14].

Despite the high incidence of chipping and debonding resulted in high early complication rates of veneered zirconia restorations [8, 15], much more successful was the clinical testing of zirconia IR-RBFPDs, which have demonstrated high survival rates in the mid-term [1, 16]. The retention was improved by the addition of oral and buccal wings, and a partially monolithic design (only the pontics were veneered with feldspathic ceramic) reduced the susceptibility to chipping [17].

As regards the researches on lithium-disilicate ceramics, Edelhoff and al investigated the outcome of three-unit IRFDPs fabricated from heat-pressed lithium-disilicate. They recorded; in their study; 3-year survival rate of 90.09%, thus the short term outcome of IRFDPs appeared promising. On the contrary, a 15- year prospective clinical study showed a high failure rate (18). They conclude that these restorations, often, failed to whistand posterior masticatory forces and have a low probability of survival (57%, 38%, and 22% after 5, 8, and 15 years, respectively). The failures described are mainly due to framework fracture and debonding of one or both retainers. As a result, they are not recommended for regular clinical use. Nevertheless, the estimated survival rate of hybrid retained FDPs (one abutment tooth with an inlay retainer and one with a full crown retainer) was about 100% after 5 years, 60% after 8 years and 15 years. Accordingly, a laboratory experiment recommended lithium-disilicate CIR-FDPs only for patients with low biting forces [19]. Nevertheless, given that these investigations started in the 2000s, further research with recently improved lithium-disilicate materials and enhanced bonding methods should be conducted to redefine these conclusions [14, 20].

In fact, new microstructure in glass-ceramics has been recently developed with the optimized behavior in mechanical properties and optical features. This novel microstructure is lithium silicate glass-ceramic reinforced with zirconium dioxide crystals (21). An in vitro study investigated the mechanical durability of inlay-retained FPDs made from zirconia reinforced lithium silicate and conclude that this material failed at a significantly lower load than monolithic zirconia FPDs. In 2012, an in vitro study with finite element analysis showed that embedded Zirconia bar of an IPS–Empress 2 inlay-retained fixed partial dentures decrease stress concentration in the connector area [5]. For Kolbeck and al; different recently-marketed lithium-disilicate ceramic materials demonstrated sufficient fracture strength to be considered for metal-free inlay-retained prostheses. However, clinical relevance regarding mechanical and fatigue loading is limited and further in vitro investigations are required to draw firm conclusions in this respect [22].

A fracture-resistant material is not the only important factor to ensure clinical success of all-ceramic IRFDPs: a reasonable framework design and precise tooth preparation seem to be of high relevance.

In fact, a systematic review published on 2018 revealed that all the inlay cavities followed the ideal design described by Thompson and al in their literature review: cavity depth of 1.5–2 mm; maximum isthmus width of one-third of the total intercuspal width; total occlusal convergence angle of 20, and all of the internal line angles rounded and smoothed to reduce stresses. However, they stated that the preparation geometry must be adapted to the specific features of the ceramic materials used for manufacturing inlay-retained restorations [23].

As for several laboratory studies highlight that special attention must be paid to the connection area between the bridge elements, because connectors and retainers at the isthmus portion of the inlay [24] represent the weakest parts either in zirconia or lithium disilicate CIR-FDPs [14], a finite element analysis was conducted in 2021 [3]. This study conclude that from a biomechanical point of view, the inlay-retained bridge for single-tooth replacement is a viable alternative for patients with a minimum coronal tooth height of 5 mm, parallel abutments, and a maximum mesio-distal edentulous space of 12 mm. Occluso-gingival height of 4 mm has been also suggested to reduce the failure probability [25]. The recommended connector dimensions in all-ceramic posterior inlay-retained fixed partial dentures varied between 9 mm² to 16 mm², with no significant differences when zirconia was used as the frame material [19], while lithium-disilicate ceramic required 16 mm² at least [14]. Thus, increasing the ceramic thickness; especially; in the connector areas and selecting a ceramic material with a high modulus of elasticity are methods for improving the load bearing capacity of inlay-retained FPDs. Thompson *et al*., added that a broadening of the gingival embrasure facilitated the distribution of the forces derived from mastication [26].

In this case report, the restoration should have been fabricated from lithium disilicate glass-ceramic reinforced with zirconium dioxide crystals (Suprinity®); as long as; this ceramic can be etched with hydrofluoric acid and cemented with adhesive luting materials which guarantees a more predictable bonding protocol than zirconia restorations. This material revealed; too: higher mechanical properties including flexural strength (444 ± 39 MPa), elasticity modulus (70.4 ± 2 MPa) and fracture toughness 2.3 ± 2 MPa m0.5 compared with lithium disilicate which presented lower values for the same properties 348 ± 29 MPa, 60.6 ± 1.6 MPa and 2 MPa m0.5, respectively [27]. But, in the absence of a sufficient block for milling the bridges, the restoration was fabricated from lithium disilicate glass-ceramic.

The preparation was initiated in the proximal defects and was extended occlusal for better resistance. It was found that restorations with retainers prepared as occlusal-proximal inlay showed the highest fracture resistance for replacing missing premolars and molars; while those with box-shaped preparations disclosed the lowest fracture resistance. This extension permit to enlarge the area bonded to enamel surface for better bonding results. It was performed without coincidence of margins with occlusal contact points. Then an Immediate dentin sealing was performed; the dentin was sealed with adhesive in order to prevent contamination, hypersensitivity and microfiltration [14].

Tooth mobility and occlusal loading conditions have also to be considered. A finite element analyses stated that the simulated stress distribution is strongly influenced by these factors. Also the eccentrically loading of the pontics has been described to have an influence in decementation [11, 14].

After finishing the bonding protocol, the occlusion was verified and a meticulous polishing was performed.

Conclusion

A careful case selection along with appropriate abutments' preparation and luting procedures may be decisive for the clinical success of IRFDPs. These restorations can be recommended as viable short- or middle-term minimally invasive alternative to short-span conventional FDPs and ISCs, while the clinical outcome of IRFDPs as long-term definitive restorations still calls for further research [4].

Conflict of Interests: The authors declare that there is no conflict of interests regarding the publication of this paper.

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