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Endocrown: an alternative modality to restore extensively damaged molars – case reports

Endokorona: alternatywny sposób odbudowy zniszczonych trzonowców – opis przypadków

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Summary

Restoring endodontically treated teeth with extensive coronal destruction is still a clinical challenge for dentist.With the advent of adhesive dentistry, new approaches to restoring the tooth have emerged. Among them, the endocrown; it is described as a monolithic ceramic bonded construction invading the pulpal chamber, but not the root canals.

The endocrown is convenient for all molars, particularly those with clinically low crowns, calcified root canals, or narrow canals. It requires specific preparation techniques.

This paper aimed to describe, through clinical cases, the technique of preparation, the indications, correct choice of material, the steps of the bonding protocol and the use of endocrowns in order to restore endodontically treated molars.

Streszczenie

Odbudowa zębów leczonych endodontycznie z rozległym zniszczeniem korony jest nadal wyzwaniem klinicznym dla dentysty. Wraz z pojawieniem się stomatologii adhezyjnej zaproponowano nowe podejścia do odbudowy zęba. Jednym z rozwiązań jest endokorona, monolityczna konstrukcja wykonana z ceramiki wypełniająca komorę miazgi.

Endokorona jest zalecana do wszystkich zębów trzonowych, szczególnie tych z klinicznie niskimi koronami, zwapnionymi lub wąskimi kanałami korzeniowymi. Wymaga specjalnych technik preparacji.

Celem pracy było opisanie przypadków klinicznych, techniki preparacji, wskazań, prawidłowego doboru materiału, poszczególnych etapów procedury bondingu oraz zastosowania endokoron w celu odbudowy zębów trzonowych leczonych endodontycznie.

Introduction

The restoration of damaged and endodontically treated teeth is often required and may represent a challenge, as there is no consensus on the ideal type of treatment. The traditional approach is to place a full crown and a post, core to ensure retention of the restoration after the endodontic treatment.[1] However, there are many risks associated with placing a post including perforation during post preparation, tooth fracture due to the removal of dentine, or failure.[1]

Currently, the concepts of tissue economy and therapeutic protocol have been integrated into our daily practice. This is mainly due to the advancement of new digital technologies and the contribution of recently introduced aesthetic materials. According to therapeutic protocol, partial restorations, like endocrowns, represent a promising treatment alternative for endodontically treated molars with large coronal destruction.[2] It is described as a monolithic construction characterized by a supra cervical butt joint retaining maximum enamel volume to improve adhesion and invading only the pulpal chamber to improve retention.[3]

Basing on the findings of a 2019 systematic review, the authors found that excellent survival rates had been reported in the short, medium, and long term for molars restored with endocrowns.[4] A study reported that endocrowns had fewer catastrophic failures than crowns (with or without post-retained restoration), with 6% of root fractures for endocrowns and 29% for crowns.[5] This partial restoration requires specific preparation design and rigorous adhesion protocol.

The use of CAD/CAM technology and digital scanning ensure a precise marginal adaptation and rapid design of the endocrown, but in some situations, we are often confronted with an infragingival limit that complicates the conventional or digital impression, the placement of a rubber dam and especially the bonding protocol. In such cases, a more conservative technique involves relocating the cervical margin of teeth with subgingival defects to a supragingival position with a plastic-phase material: Deep Margin Elevation (DME).[6]

On the basis of two clinical cases this paper aimed to describe the technique of preparation, the indications, correct choice of material, the steps of the bonding protocol and the use of endocrowns to restore endodontically treated molars.

Case report 1

A 23-year-old female patient was referred to the fixed prosthodontics department at the dental clinic of Monastir to restore extensively damaged maxillary right first molar (16). The medical history was noncontributory. On clinical examination, an extensive glass ionomer cement restoration of a nonvital tooth, an acceptable oral hygiene and a favourable occlusion were found (Fig. 1). A radiographic examination revealed that it was well-endodontically treated (Fig. 2). Prosthetic decision: after removing the restoration, the residual tooth walls were supragingival (Fig. 3) an endocrown restoration fabricated from lithium disilicate ceramic (IPS e.Max CAD) was recommended.

Tooth preparation

- The preparation for the endocrown is different from the conventional complete crown.
- The preparation consisted in reducing the height of the occlusal surface of at least 2 mm in the axial direction and getting a cervical margin in the form of a butt joint.
- The cervical margin has to be supragingival and enamel walls less than 2 mm have to be eliminated.
- Differences in levels between the various parts of the cervical margin should be linked by a slope of no more than 60° to escape a staircase effect.

Fig. 1. Initial situation.

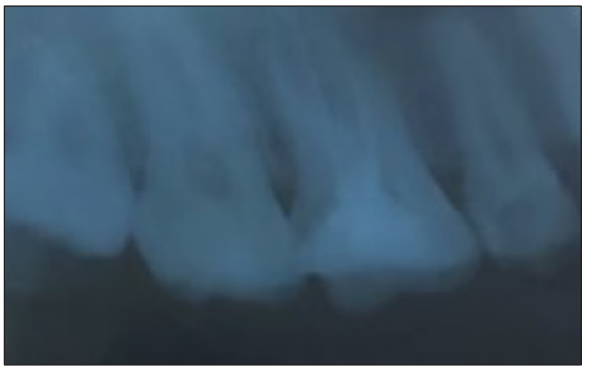

Fig. 2. Pre-operative radiograph: good proper endodontic treatment.

Fig. 3. Occlusal view after removal of the glass ionom er cement restoration.

Fig. 4. Occlusal view after the preparation.

Fig. 5. Temporary restoration.

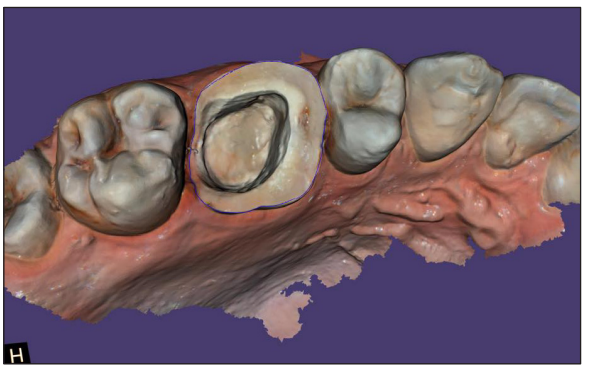

Fig. 6. Digital impression of the maxilla.

– A cylindrical-conical diamond bur was used with a total occlusal convergence of 7° to create continuity between the coronal pulp chamber and endodontic access cavity.
– The depth of the cavity must be at least 3 mm.
– The preparation with lining the root canal entrances was performed with glass ionomer cement to protect the orifice of the canal (Fig. 4).
– Finally, the surface was polished with a finer particle size bur than used in axial preparation to remove micro-irregularities.

The temporary restoration was made with self-polymerizing acrylic resin and cemented (Fig. 5). The digital impressions were taken by scanning the maxillary, the antagonist and the

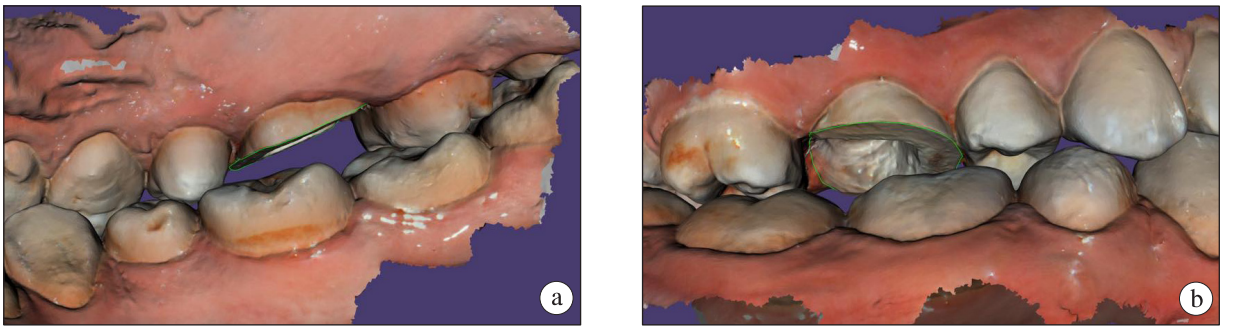

Fig. 7. Digital impressions of the antagonist and the vestibular side of the relevant occlusion sector.

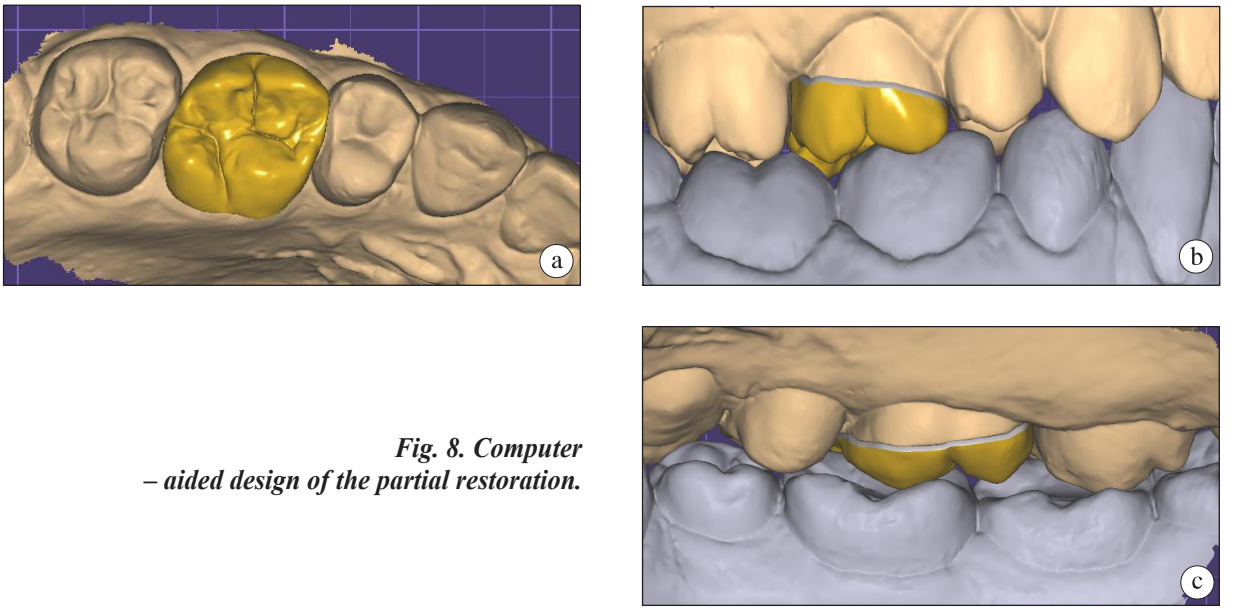

Fig. 8. Computer – aided design of the partial restoration.

vestibular aspect of the relevant occlusion sector (Figures 6, 7). In laboratory, the endocrown was manufactured with computer-assisted design CAD/CAM semi direct technique (Figures 8, 9). Cementation: the endocrown was tried in. Once validated, it was cemented using dual polymerizing resin (Fig 10).

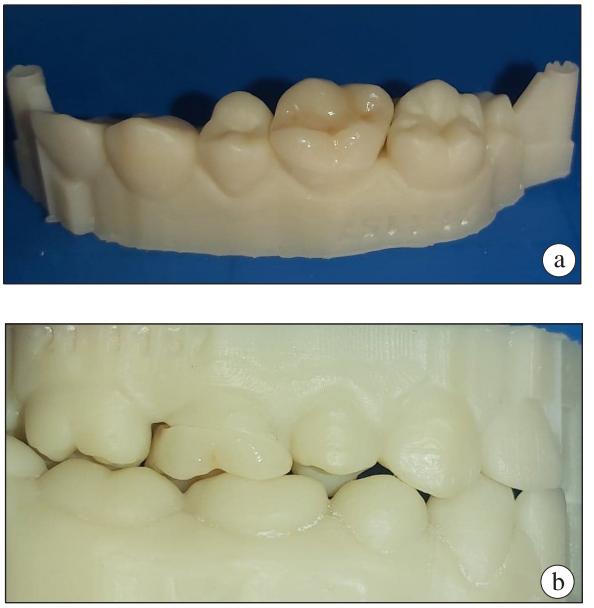

Fig. 9. Vestibular view of the Endocrown endocrown in the master cast.

Fig. 10. Occlusal view after the cementation of the endocrown.

Case report 2

A 28-year-old female patient was referred to the fixed prosthodontics department at the dental clinic of Monastir to restore her two extensively damaged mandibular molars. The medical history was noncontributory.

Clinical examination revealed an extensive restoration of mandibular molars (36 and 37), acceptable oral hygiene and a favourable occlusion (Fig. 11). A radiographic examination revealed that it was well-endodontically treated (Fig. 12). Prosthetic decision: after removing the restoration, the residual tooth walls were juxta gingival – 2 endocrown restorations which were fabricated from lithium disilicate ceramic using indirect CAD/CAM, (IPS e.Max CAD). The endocrown preparation consisted in reduction in the height of the occlusal surface of at least 2 mm in the axial direction, eliminating undercuts in the access cavity and finally polishing the Cervical Band. Because the residual tooth walls were juxta gingival, the cervical margin was relocated by placing a composite resin base at the proximal gingival cavity margins: deep margin elevation (Fig. 13).

A complete arch impression was taken with a silicone impression material (HydroC, Detax, Germany) (A combination of heavy-low and light silicon) (Fig. 14) and the impression of the antagonist arch was taken with alginate.

In laboratory, the working cast was scanned and endocrowns were manufactured with computer-assisted design CAD/CAM indirect technique.

The temporary restoration was made with self-polymerizing acrylic resin (DentoCrown, ITENA, France), in shade A1, with adequately

Fig. 11. Two extensive cavit restorations of mandibular molars (36 and 37).

Fig. 12. Satisfactory endodontic treatment.

Fig. 13. Preparation + deep margin elevation.

Fig. 14. Master Impression.

Fig. 15. Temporary restoration.

Fig. 16. After cementation.

Fig. 17. Final result.

adapted gingival margins to ensure healthy gingival tissue (Fig. 15). Before cementation, the endocrowns were tried in. The rubber dam was used to minimize contamination before final placement of the pieces. The teeth surfaces were etched with 37% phosphoric acid for 30 s for the enamel tissue and 15 s for the dentine, followed by rinsing with spray and gentle drying. The adhesive system (Syntac-ivoclar®) was applied for 20 seconds.

The restorations received hydrofluoric acid surface treatment (Ceramic Etching Gel, IvoclarVivadent ®) for 20 seconds followed by rinsing and drying. Next, silane (Monobond-S, IvoclarVivadent®) was applied for 60 seconds, and dried. A dual polymerizing resin (Variolink N, Ivoclar Vivadent) was applied to the prosthetic piece, and polymerized for 5 seconds to remove excess cement. A flash polymerisation was applied to remove excess glue. Finally, a glycerin layer was applied to the piece and the tooth, and resin cement was light cured for 60 s for each surface aiming to block the oxygen. Some occlusal adjustments were necessary after cementation followed by polishing with Ceramic Polisher Cups (Fig. 16). The patient was satisfied with the good result (Fig. 17).

Discussion

According to therapeutic protocol, partial restorations like indirect onlays, overlays, endocrowns are becoming increasingly popular and have been suggested as an alternative to full crowns as they preserve more sound tooth structure while providing cuspal coverage to protect weakened cusps. In both clinical cases, depending on the extent of decay of the teeth, inlays -onlays cannot be considered a therapeutic solution. So, endocrown represents a promising treatment alternative for endodontically treated molars with a large coronal destruction.[7] It is described as a monolithic construction characterized by a supra cervical butt joint retaining maximum enamel to improve adhesion and invading only the pulpal chamber to improve retention.[3] Based on the systematic review, the authors found that excellent survival rates had been reported in the short,

medium, and long term for molars restored with endocrowns. A study reported that endocrowns had fewer catastrophic failures than crowns (with or without post-retained restoration), with 6% of root fractures for endocrowns and 29% for crowns.[5] The endocrown is indicated for successfully root treated molars and premolars with a large pulpal chamber (depth upto 4-5 mm), molars with short calcified canals or short crown and supragingival margin.[8]

The contra-indications of an endocrown are: parafunctional habits, depth of pulp chamber less than 3 mm, cervical margin less than 2 mm wide and if isolation cannot be assured.[8] That is why, in the second case, the residual tooth walls are juxta gingival: the cervical margin was relocated by placing a composite resin base at the proximal gingival cavity margins using plastic phase materials: deep margin elevation. This technique is considered a new approch and can replace the invasive procedures of crown lengthening.[9]

Margin elevation can be performed using a host of different materials, such as composites, glass ionomers or resin-modified glass ionomers. The following steps are recommended.[6] The working field should be completely isolated to improve the visibility of margins. The use of a matrix aims to obtain a perfect cerclage of the cervical limit: sectorial matrices with extension or circumferential matrices such as tofflemire are recommended. Pre Curved matrices are preferable since they provide a better gingival emergence profile. The choice of the adhesive system: MR3 systems are preferred because of their high performance and resistance to degradation.

The right choice of biomaterial: several authors recommended the use of CVIMARs for their ability to release fluoride and inhibit the formation of bacterial biofilm on their surface. However, their high sensitivity to water degradation and their low mechanical strength compromise their life span. The use of preheated medium viscosity micro-hybrid or nano-hybrid composites is therefore preferred so that they perfectly adapt to the dental walls and further facilitate placement. Composite can also be used to correct geometry and eliminate undercuts to improve the principle of tissue economy.

An in-vitro study reported that deep marginal elevation enhances both marginal adaptation and fracture resistance of endocrowns constructed with IPS e.max CAD and Vita Enamic.[10] The clinical success of the endocrown is conditioned by appropriate preparation techniques. Several typologies exist in the scientific literature. According to *Mostafavi* et al. the preparation of the circular cervical butt margin should be with a minimum of width and height of 2 mm.[11] The surface should be flat, perpendicular to the major axis of the tooth parallel to the occlusal plane to provide stress resistance along the major axes of the tooth and with a band of peripheral enamel that optimizes bonding. The preparation of the pulp chamber consists of an undercutting with a cylindrical-conical diamond bur by realizing a geometrical anti-rotational shape thanks to the shape of the pulp chamber to ensure stability and retention.[7] Some authors believe that to increase retention, root canal filling material can be removed to a maximum depth of 2 mm. Or according to the 2017 study by *Gulec* and *Ulusoy*, endocrowns without intradicular extensions show better adaptation.[12] When the bottom of the pulp chamber is not completely flattened, the incidence of adverse failures may increase and the preparation impression and endocrown design may be compromised.

Endocrowns can be fabricated by different methods like a conventional heat-pressed or computer-aided design/computer-aided manufacturing (CAD/ CAM) system. All materials that can be acid-etched and resin-bonded to tooth tissue are recommended for endocrown restoration as the retention depends

mainly on bonding. Thus, lithium disilicate glass-ceramics, hybrid nanoceramics, fiber-composites and zirconia-reinforced lithium silicate glass-ceramic are all materials that could be milled for the fabrication of endocrown although their microstructure and physical properties are different.[13]

According to the 2019 study by *Wiem El Ghoul* et al., lithium disilicate endocrowns show better fracture resistance for axial and lateral loads followed by nanoceramic resin and lastly zirconia-reinforced lithium disilicate-based glass-ceramic.[14] According to the 2019 *in-vitro* study by *Tribst* et al. on, lithium disilicate endocrowns show higher load-to-failure than leucite-based glass-ceramics after mechanical fatigue.[15] Lithium disilicate is one of the most used materials for endocrown due to its high bonding strength and optical and mechanical properties.Yet, zirconia endocrowns show higher fracture load than lithium disilicate endocrown according to the *in-vitro* study by *Cekic* et al.(2018).[16] Resin composite materials have recently been developed and used. According to the *in-vitro* study by *Sedrez Porto* et al. (2020), Bulk Fill endocrowns showed better fracture resistance than lithium disilicate glass-ceramics.[13]

Recently, polyetheretherketone (PEEK), a new polymer, has been applied to dentistry: a modified PEEK material embedded with 20% ceramic fillers (BioHPP; Bredent GmbH). PEEK endocrowns have better fracture resistance than zirconia-reinforced lithium disilicate glass-ceramics and lithium disilicate ceramics thanks to its major advantage namely the modulus of elasticity.[17] Ceramics, thanks to their high chemical stability, have good optical and mechanical properties, as well as excellent biocompatibility but repairs remain problematic once they have been placed mouth. Composites are easier to handle and repair, but have inferior mechanical and biocompatible properties to ceramics. For this reason, thanks to the development of CAD/CAM some authors have suggested combining the modulus of elasticity of composites, which is similar to that of dentine, with feldspathic ceramics which have a modulus of elasticity similar to enamel with the aim of creating the most durable and optimized restorative qualities: the so-called "hybrid" blocks or "hybrid" ceramics.[18]

Resin nano-ceramic endocrowns have similar or better fracture resistance and fewer catastrophic failures when compared to lithium disilicate endocrowns. Further studies are therefore needed to confirm the superior mechanical behaviour of hybrid ceramics over lithium disilicate. In the meantime, IPS E.max® remains the material of choice for endocrowns.[19] To guarantee the success of bonded partial restorations, it is necessary to know the indications for this type of restoration, to choose the right material and to respect the bonding protocol. Therefore, in the case of endocrowns, our choice to use dual cement was justified by the fact that the lightcuring unit light needed to pass through the ceramic thickness. An adhesive with no adhesion potential are the adhesives with the best clinical performance and the best results in terms of mechanical and aesthetic properties. They appropriately meet the requirements for reliable, durable and aesthetic bonding.[19]

Conclusions

1. Endocrown can be an excellent option for restoring severely damaged teeth, specially in molars than premolars.
2. Fabricated from lithium-disilicate glass-ceramic, endocrowns yielded highly successful results in aesthetic aspects and ensured mechanical strength.
3. Deep margin elevation is a relatively recent technique whose benefits seem recognized, not forgetting the advantage of using optical impressions for quick and easy design of endocrowns.

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