CASE REPORT / *CAS CLINIQUE*

Prosthodontics / *Prothèse Fixée*

ENDOCROWN, FROM PREPARATION TO BONDING: CASE REPORT

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Abstract: The restoration of endodontically treated teeth is a real challenge, particularly teeth with extensively damaged coronal tissues. The use of post-retained restorations has been discussed because of the potential tooth weakening due to the additional removal of sound dental structures. In fact, long-term prognosis of a devitalized tooth is closely related to the coronal restoration's quality and the remaining dental structure.
With the development of adhesive dentistry and minimally invasive preparation, new approaches have emerged. Among them, the endocrown which is monolithic ceramic bonded restoration, anchored to the internal portion of pulp chamber and cavity margins that have been used as an alternative to conventional post and core.

Keywords: Endocrown, Endodontically treated teeth (ETT), Bonding, Minimally invasive restoration, Deep margin elevation (DME), Immediate Dental Sealing (IDS)///

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The authors declare no conflicts of interest.

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ENDOCOURONNE, DE LA PRÉPARATION AU COLLAGE : CAS CLINIQUE

Résumé: La restauration des dents traitées endodontiquement constitue un véritable défi, notamment pour les dents dont les tissus coronaires sont gravement endommagés. L›utilisation de restaurations avec tenon radiculaire a été discutée en raison de la fragilisation des dents liée à l›élimination supplémentaire des structures dentaires saines. En effet, le pronostic à long terme d›une dent dévitalisée est ét oitement lié à la qualité de la restauration coronaire et à la quantité des tissus dentaires résiduels.
Avec le développement de la dentisterie adhésive et des préparations mini-invasives, de nouvelles approches ont émergé. Parmi celles-ci, l'endocouronne, qui est une restauration en céramique monolithique ancrée à la partie interne de la chambre pulpaire et aux bords de la cavité, représente une alternative aux inlay-core

Mots clés: endocouronne, dent traitée endodontiquement, collage, dentisterie mini invasive, remontée de marge, scellement dentinaire immédiat

Introduction

The rehabilitation of teeth with endodontic treatment is a tough task in restorative dentistry due to the diversity of clinical situations [1].

Conventionally, the restoration of endodontically treated teeth (ETT) was associated with the use of crowns and posts that aim to intensify the retention of the core foundation, led to a 58.3% loss of tooth structure [2] and enhanced the risk of accidental root perforation and fracture [3].

Taking advantage of the increasing interest in minimally invasive restoration and the advent of dental materials, endocrown was introduced as a more conservative approach to rehabilitate damaged ETT [4, 5]. Thus, the adhesive qualities of the bonding material make the use of intra-radicular posts unessential, thereby avoiding root fragilization caused by drilling and the stresses associated with posts [6].

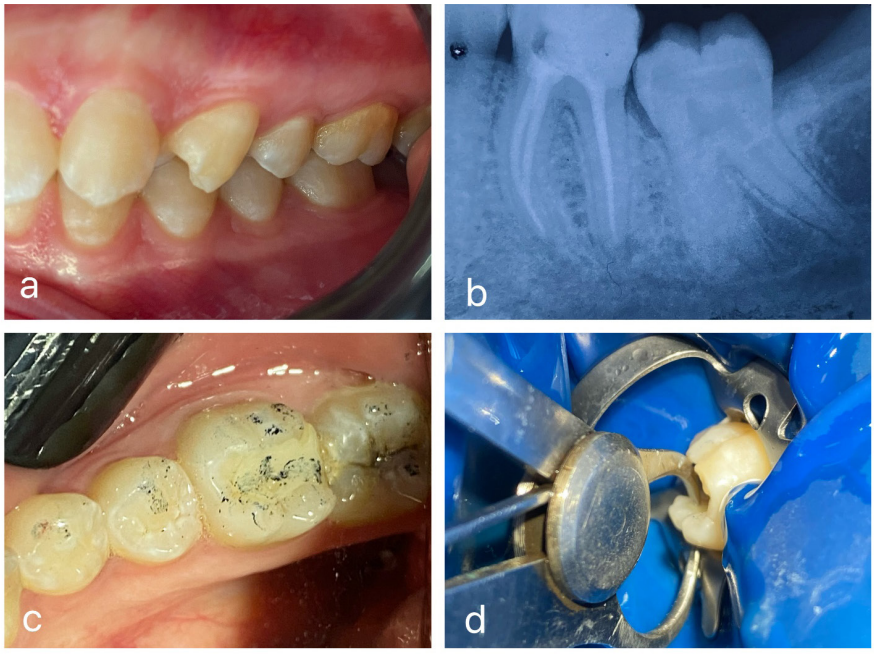

Figure 1. (a) Occlusion in left lateral view; (b) preoperative periapical x-ray; (c) Intraoral picture of the preoperative condition of the 36 and marking the occlusal contacts with 80 μm articulating paper; (d) measuring the thickness of the residual wall: less than 2 mm.

An endocrown is a monoblock ceramic bonded restoration with a supra-gingival butt joint margin, designed to preserve maximum enamel for improved adhesion. It utilizes the pulp chamber to enhance macro-mechanical retention of the crown, a concept pioneered by Pissis in 1995 [7].

Furthermore, the endocrown offers several advantages, such as a straightforward procedure and superior biomechanical performance compared to conventional restorations. Additionally, with modern CAD/CAM technology, treatment efficiency and aesthetic outcomes are optimized, ensuring patient satisfaction [8].

All ceramic endocrowns, particularly those made from lithium disilicate enhance the fracture resistance of ETT [9]. Molars restored with these crowns have shown survival rates exceeding 90% over 6 months to 10 years [10].

This paper aims to present a clinical case in which a lithium disilicate endocrown, manufactured using CAD/CAM technology, was used to restore a mandibular molar after undergoing endodontic treatment and significant coronal destruction. The focus will be on outlining the essential steps for successful preparation and implementing a reliable bonding protocol for the endocrown restoration, ensuring its long-term durability under normal oral functional conditions.

Case Presentation

A 22-year-old female was referred to our Department of Fixed Prosthodontics at the Dental Clinic of Monastir to restore her first left mandibular molar. The patient was dissatisfied with the current restoration and sought an aesthetic and functional prosthesis.

The medical history was noncontributory. Radiographic and clinical examinations revealed a large composite restoration with recently completed endodontic treatment (Figures 1a to c).

The patient had insufficient oral hygiene and a favorable occlusion. After removing the composite restoration except on the distal side for marginal relocation, and reducing the undermined cusps, an endocrown (IPS e.max CAD) was recommended due to the amount of remaining tooth structure, the thickness of the walls, and the short clinical crown height (Figure 1d).

The preparation of an endocrown differs significantly from conventional full-coverage crowns in several key aspects:

Firstly, the primary aim is to achieve a minimum 2 mm reduction in the height of the occlusal surface along the axial direction. This process involves the initial drilling of 2 mm deep grooves as guides, followed by meticulous reduction using a green diamond wheel bur.

The diamond bur is guided along the tooth's long axis, maintaining parallelism to the occlusal plane. This ensures precise alignment to create a flat surface essential for determining the cervical margin or "cervical sidewalk".

Ideally, the margins of the endocrown should be kept supragingival for an optimal bonding protocol. In areas where aesthetic considerations are paramount, transitions between different cervical levels should slope no more than 60°. Any

Figure 2. Buccal view of the preparation and the cervical margin.

Figure 3. Occlusal view of the preparation and the IDS.

weakened enamel less than 2 mm thick should be carefully removed to ensure structural integrity.

The cervical sidewalk forms the sturdy foundation of the restoration. The goal is to achieve a wide, uniform surface that can withstand compressive stress effectively (Figure 2).

Secondly, during the axial preparation phase, the priority is to eliminate undercuts from the access cavity. This is achieved using a cylindrical-conical coarse grit diamond bur with a 7-degree occlusal taper to ensure seamless continuity between the pulp chamber and the endodontic access cavity. Careful attention is given to aligning the diamond bur parallel to the tooth's long axis while avoiding excessive pressure to protect the pulpal floor. It is crucial to avoid over-reduction of the pulp chamber walls, which could compromise their thickness and reduce the width of the enamel strip. The cavity must be prepared to a minimum depth of 3 mm to ensure the longevity and effectiveness of the restoration.

Then, polish the cervical band using a bur that has a taper similar to the one used in axial preparation but with a larger diameter and finer particle size. Guide the bur around the entire cervical band to smooth out micro-irregularities and achieve a flat and polished surface. This process ensures that the margin line appears even and well defined with a sharp edge.

Ultimately, the gutta-percha is removed to a depth not exceeding 2 mm with a non-abrasive instrument to maintain the integrity of the canal entrances without drilling into the dentin. Immediate dental sealing is then applied for the freshly cut dentin and flowable composite is used to cover the orifices of the root canals, ensuring their protection (Figure 3).

Subsequently, a one-step impression of the prepared tooth, along with the shape of the pulp chamber, was taken by an additional silicone (Accusil combo kit: putty +light body) (Figure 4) and shade selection was performed using VITA Tooth guide 3D-MASTER. Next, a provisional acrylic resin restoration was fabricated and cemented using eugenol-free temporary cement (Figure 5).

Following this, the endocrown was manufactured using the CAD/CAM technology (IPS e.max CAD, Ivoclar Vivadent), which minimizes clinical adjustment procedures and allows the treatment to be performed in a single session (Figure 6).

After checking the occlusion, internal and proximal adjustments, the inner surface of the endocrown was etched with 9 % hydrofluoric

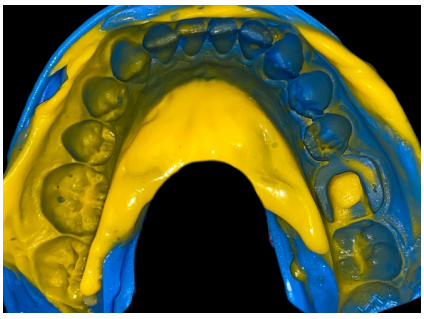

Figure 4. Impression

Figure 5. Provisional restoration.

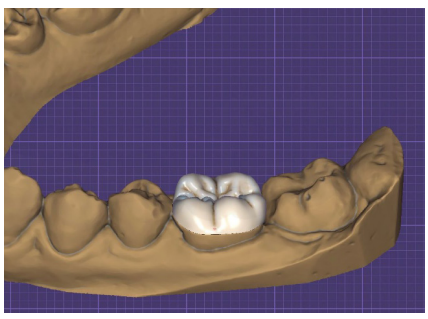

Figure 6. Design of the endocrown.

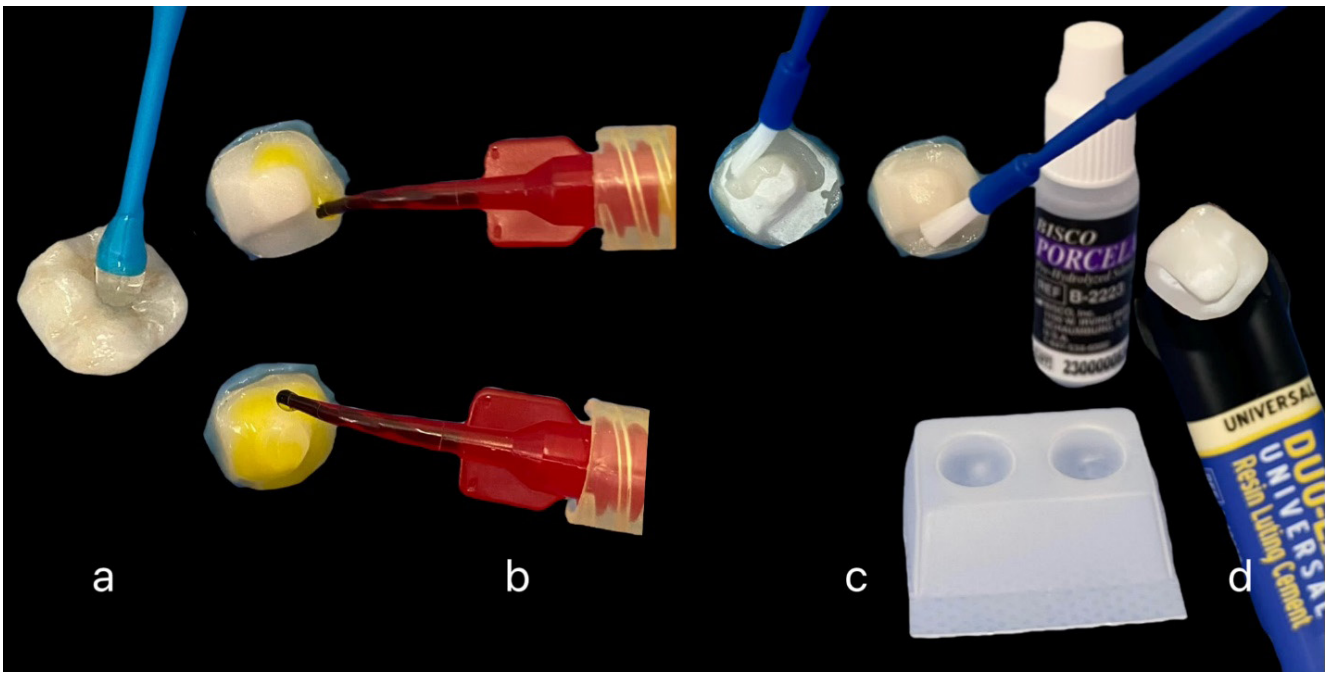

Figure 7. (a) Lithium disilicate endocrown; (b) Hydrofluoric acid applied for 20s; (c) BISCO's PORCELAIN PRIMER applied for 30s ; (d) DUO-LINK UNIVERSEL Resin Luting Cement BISCO

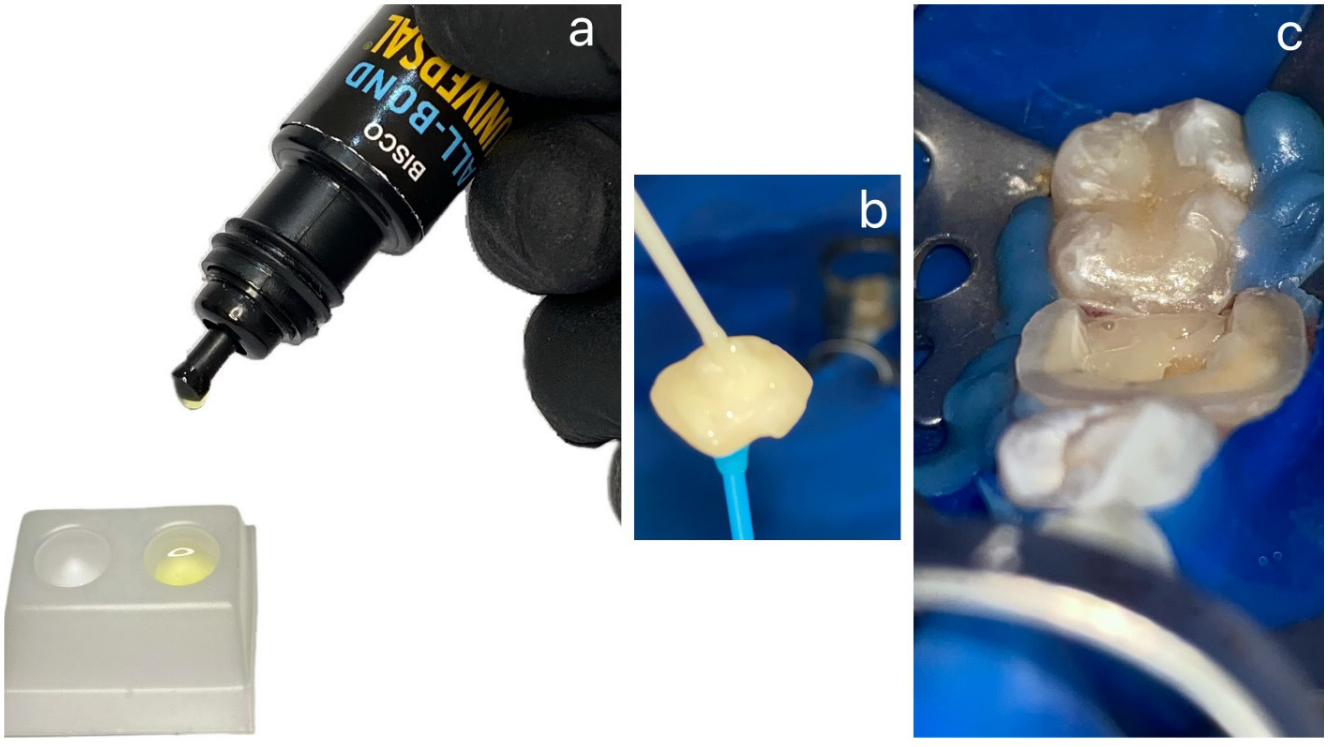

Figure 8. (a) BISCO's ALL-Bond UNIVERSAL Adhesive; (b) and (c) the resin cement applied to the endocrown and the tooth.

acid for 20 s, rinsed with water, and dried using an air syringe. A coat of silane, such as BISCO's PORCELAIN PRIMER was applied for 30 s and dried with an air syringe (Figures 7a to d). Rubber dam was used to achieve proper isolation and a selective enamel etch was performed to increase mechanical retention.

Two coats of ALL-BOND UNIVERSAL adhesive, which contains 10-MDP, were applied with a micro brush and light-cured for 10 s (Figure 8a). A thin layer of BISCO's DUO-LINK UNIVERSAL cement was

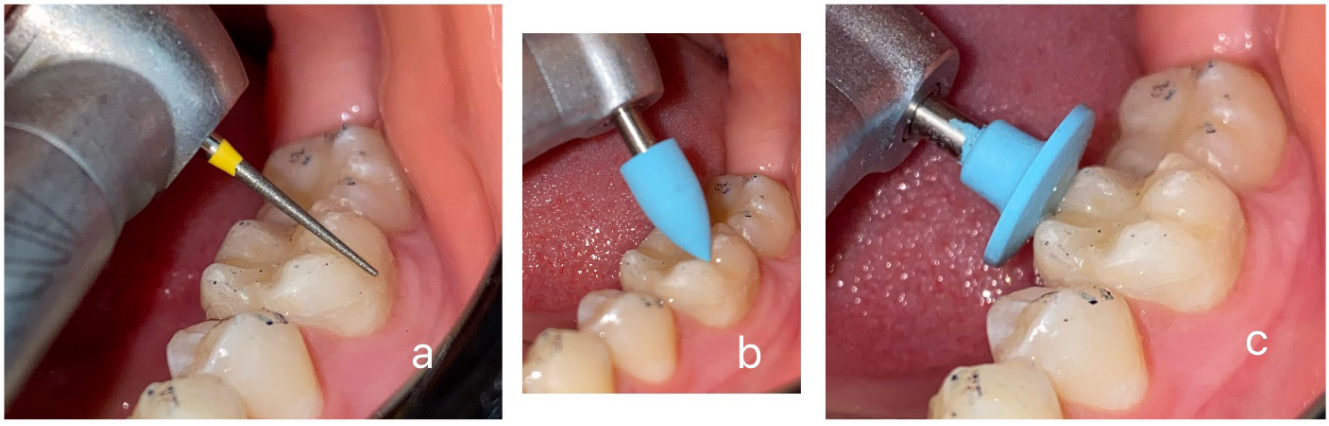

Figure 9. After checking the occlusion, the adjusted surfaces should be polished with ceramic polishers a, b, c.

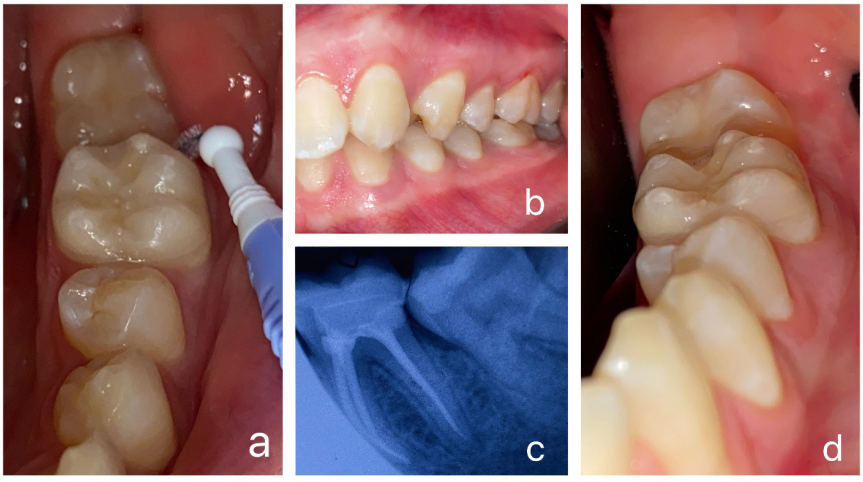

Figure 10. (a): Instructions for using the interproximal brush to achieve effective removal of dental plaque; (b): lateral view of the occlusion; (c): post-operative x-ray shows a good marginal fit; (d): post-operative picture of the cemented endocrown

applied to the bondable surfaces of the restoration and the intaglio surface of the endocrown (Figures 8b and c) and then it was introduced into the tooth. Excess cement was gently removed with a brush before spot curing the margins for 2-3 s per quarter surface. Each surface of the restoration may be cured for up to 40 s after removing all excess cement. Finally, the crown was examined for any occlusal interferences, and occlusal adjustments were polished with ceramic polishers (Figure 9). Instructions were given for using the interproximal brush to achieve effective removal of dental plaque (Figure 10).

Discussion

Endocrown is a highly recommended restorative option for restoring ETT [7]. Compared to conventional treatment, it preserves dental tissues and reduces the risk of tooth fracture [11]. Furthermore, endocrown has superior fracture resistance when compared to those restored with hybrid post-core and crown [12], better marginal fit and less marginal leakage especially with butt-joint margin [13]. Moreover, the retention of these crowns mainly depends on bonding, which is achieved through the internal portion of the pulp chamber and the cavity margins. Therefore, macro-mechanical retention is provided by the pulpal walls, while micro-mechanical and chemical retention are achieved through adhesive cementation [14].

Endocrowns are indicated in cases of molars with calcified, short, curved or fragile roots that make post-application impossible. They may also be used in situations of excessive loss of coronal substance and limited interocclusal space, in which an adequate thickness on the ceramic substructure or the ceramic covering on the metal isn't attainable [13]. However, the endocrown is contraindicated in cases where the pulp chamber depth is less than 3mm, in unfavorable occlusal settings (such as parafunction), or when the thickness of the peripheral walls is less than 2mm and reliable adhesion cannot be ensured [6].

Einhorn and al evaluated the effect of preparation ferrule inclusion with fracture resistance of mandibular molar endocrowns. Their results showed that the more complex the preparation design became because of the ferrule addition, the resultant endocrown inner surface appeared to adapt less to the preparation with 1 mm and 2 mm designs with larger cement space. Another preparation parameter was the tooth structures limitation in the cervical area. Nevertheless, ferrule-containing endo-

crowns preparations revealed significantly higher failure loads than standard endocrown restorations (zero ferrule) [15].

The trapezoidal form of the pulp chamber in lower molars and triangular form in upper molars improve the restoration's stability, and additional preparation is unneeded. This anatomy, combined with the adhesive properties of the bonding material, makes it unnecessary to involve the root canals. Consequently, compressive stresses at the tooth-restoration interface are effectively dissipated across the entire restored tooth structure [6].

The vast variation of available materials makes it hard to choose an appropriate one. Based on the stress distribution and levels of stresses and displacements, dental materials with high elastic modulus seem to protect dental tissues and the endocrown–tooth complex under occlusal loadings more than materials whose elastic moduli are low [3].

Mhd Ayham Darwich and al studies showed that resin nanoceramic caused high stress concentration and displacement in dental tissues, which might not make it a suitable material for endocrowns. It also caused high tensile stress in the cement line, and that may compromise the unity of the endocrown–tooth complex. Translucent zirconia might be the best material for endocrowns to preserve the tooth–restoration complex since it absorbs stresses and exhibits low displacement within it and in the dental tissues. Moreover, lithium disilicate ceramic and zirconia-reinforced lithium silicate could be used as an endocrown material as they offer an acceptable range of stresses in dental structures [3].

Currently, CAD/CAM manufactured endocrowns are extensively utilized for restoring ETT. CAD/CAM technologies enable achieving improved marginal fit, adequate strength, and aesthetic restoration [16].

Immediate dental sealing (IDS) is a procedure that involves applying an adhesive system to freshly cut dentin, aiming to create a better hybrid layer without contamination from blood and temporary cement. In contrast, the bond strength significantly decreases under delayed dentin sealing (DDS) after temporary cementation [17].

The reinforcement of an adhesive system with a layer of flowable resin composite seems to considerably improve the bond strength in the long term [18].

Xia Cheng and al analyzed the stress distribution of the all-ceramic endocrown with different base materials and thicknesses they concluded that the base layer played a force buffering effect on the tooth restored with endocrown, and the effect was the best at 1 mm. The selection of base material has a few overall influences. However, to protect the weak tissues at the cavity bottom, a base material with lower elastic modulus can be used [19].

Besides, the fracture resistance of teeth restored with DME is not significantly different from teeth restored without DME. The marginal quality of DME restorations to root dentin is excellent and similar to sites without DME [20]. As well, the fracture resistance of ceramic endocrowns was increased by DME [21].

On the other side, DME restorations made with scrupulous care, promote periodontal health [22] because they are well-polished and do not intrude into the supracrestal connective tissue attachment. Additionally, teeth restored with DME and indirect restorations demonstrate better survival rates than those treated with surgical crown lengthening [23].

Based on Bresser and al studies, indirect restorations with DME have a good survival rate 95.9% up to 12 years. Yet, long-term follow-ups are required as degradation is seen in time [24].

Due to the introduction of dentin bonding agents, there has been a significant advancement in the restoration of ETT. A novel light-cured adhesive material has been created, featuring primers containing the monomer 10-methacryloyloxydecyl dihydrogen phosphate (MDP). This innovative formulation can be combined with micromechanical retention to enhance chemical bonding [25]. These adhesives have demonstrated superior bonding performance compared to materials utilizing different acidic components [26].

Further, adhesive cement is essential for enhancing the durability and performance of endocrowns by effectively distributing stress to increase fracture resistance. Resin cements, widely used in endocrown procedures, offer strong bonding, aesthetic appeal, high mechanical strength, and low solubility. They come in two types: conventional adhesive resin cement, requiring multiple bonding steps for both the tooth structure and the restoration, which increase procedure complexity, and self-adhesive cement, which simplifies the process by eliminating surface treatment but may have lower bond strength than conventional typesHaut du formulaire' [27].

Recently, a new universal resin cement has been developed. It bonds effectively to tooth structure whether an adhesive bonding agent is used or not, depending on the clinical situation. Studies indicate its performance is comparable to both adhesive cement with a bonding agent and self-adhesive cement without one [28].

Eventually, Papia and al systematic review identify retention loss and fractures as the primary factors contributing endocrown failure [29]. Adhering to adhesion protocols is fundamental for the sustainability of restorations, preventing marginal leakage and microbial infiltration towards the apex [10]. Insufficient macro retention could also explain the debonding, with stabilization through the pulpal chamber walls being less than 3mm [29].

Tribsta and al studies revealed that higher modulus increases stress on the restoration but reduces it on the cement line. Thicker restorations in

cases with minimal dental remnants concentrate stress within the structure, potentially preventing adhesive failures. Promising results are noted with endocrowns made from lithium disilicate ceramic, owing to the ceramics' stress shielding, regardless of the thickness and height of the lateral dentinal wall in the pulp chamber [30].

However, Fractures may have occurred due to constraints in the ceramic material's physical properties or the preparation design, such as insufficient ceramic layer thickness or unfavorable stress orientation or intensity. Added to this, inadequate adhesion between the restoration and dentin/enamel during cementation could fail to adequately support the brittle ceramic, thereby increasing the risk of mechanical failure [29].

Conclusion

With the progress of adhesive dentistry and dental materials, endocrown was appealed as an alternative to conventional treatment with a lower biological cost, especially for damaged endodontically treated molars. It aims to prevent the wastage of dental tissues and increase tooth longevity. This restoration is considered a conservative approach with high mechanical and aesthetic properties capable of maintaining the integrity of the tooth.

The success of endocrown restorations is greatly influenced by how well the restoration bonds to the tooth, emphasizing the crucial role of achieving optimal bonding to enhance their mechanical performance and ensure long-term durability.

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