The Endocrown: An Alternative Approach for Restoring Extensively Damaged Molars

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ABSTRACT

Endocrown-type restorations are single prostheses fabricated from reinforced ceramics that can be acid etched, indicated for endodontically treated molar teeth that have significant loss of coronal structure. Endocrowns are formed from a monoblock containing the coronal portion integrated into the apical projection that fills the pulp chamber space, and possibly the root canal entrances. In this study, the proposal was to discuss the indication and use of the endocrown to replace single crowns with intraradicular retention, and to present a clinical case report on the 3-year follow-up of an endocrown-type restoration, fabricated from injected lithium disilicate ceramic (IPS e.Max Press/Ivoclar Vivadent) in a mandibular first molar with extensive coronal destruction from fracture. It was found that endocrown restorations could be made following the development of reinforced ceramics that can be acid etched, that have aggregate strength and esthetics, that bond to the dental structure, and that have developed from broader knowledge of the biomechanical behavior of depulped teeth restored with and without intraradicular posts. Clinical studies have shown that the endocrown has functional longevity, and has become a promising alternative in the esthetic and functional recovery of endodontically treated molar teeth.

CLINICAL SIGNIFICANCE

It should be borne in mind that endocrowns offer advantages for the restoration of depulped molar teeth, insofar as they promote adequate function and offer adequate esthetics, and also maintain the biomechanical integrity of the compromised structure of non-vital posterior teeth. By eliminating the use of a post and filling core, the number of adhesive bond interfaces is reduced, thus making the restoration less susceptible to the adverse effects of degradation of the hybrid layer. In this clinical case, the 3-year survival of the endocrown restoration may be considered successful.

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INTRODUCTION

Traditionally, the functional and esthetic recovery of endodontically treated teeth with extensive coronal loss has been achieved by fabricating total crowns supported on cast metal cores.[1–6] However, with the development of intraradicular posts made of glass fiber, and of the technique of bonding to dentin, resulting from the development of resin materials, the restoration of endodontically treated teeth became simpler, more economical, and biocompatible.[7–10]

Studies showed that the use of intraradicular posts alone did not increase the retention of the

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restoration,[9,11] and that it was necessary to fabricate a filling core that would offer greater stability to the restoration. This was particularly true in the case of posterior teeth in which the direction of the main masticatory forces is parallel to the long axis of the tooth. In this case, the filling core favors retention of the restoration, even in cases of more extensive restorations such as total crowns.[12] Moreover, the placement of posts in root canals could be limited by root anatomy, such as dilacerations or reduced root portions (short roots).[13]

Therefore, with the advent of adhesive dentistry, it has become acceptable to restore teeth with extensive coronal destruction by performing onlays and overlays, without using intraradicular posts, and by using the entire extension of the pulp chamber as a retentive resource.[11,14–16] These restorative procedures were made possible by the development of acid etchable ceramics (such as leucite and lithium disilicate-based ceramics), dentinal adhesives, and resin cements. These resources may be used to perform restorations of total crowns in endodontically treated teeth, using the pulp chamber as a retentive resource, as is the case of endocrowns.[17–23]

The first study published on endocrown restoration (or adhesive endodontic restoration) was conducted by Pissis[16] in 1995. In it, he described the ceramic monoblock technique for teeth with extensive loss of coronal structure. However, it was Bindl and Mörmann[17] who named this restorative procedure "endocrown" in 1999. The endocrown is a total porcelain crown fixed to a depulped posterior tooth, which is anchored to the internal portion of the pulp chamber and to the cavity margins, thus obtaining macromechanical retention (provided by the pulpal walls), and microretention (by using adhesive cementation).[22–24]

Endocrowns are especially indicated in cases of molars with short, obliterated, dilacerated, or fragile roots. They may also be used in situations of excessive loss of coronal dental tissue and limited interocclusal space, in which it is not possible to attain adequate thickness of the ceramic covering on the metal or ceramic substructures.[24] Reinforced, acid etchable dental ceramics have been the materials of choice for the fabrication of endocrowns, because they guarantee the mechanical strength needed to withstand the occlusal forces exerted on the tooth, as well as the bond strength of the restoration to the cavity walls.[16,20,23,24]

As an upshot of this new restorative proposal, some laboratory and clinical studies have been made to evaluate the effectiveness,[20–22] feasibility,[17,18,23] and clinical performance[19–22,24,25] of endocrowns as a restorative procedure for endodontically treated teeth. However, the success and longevity of the endocrown are directly related to the correct preparation of the tooth, the selection of the most suitable ceramic options, and the choice of bonding material, since adequate adhesive cementation is absolutely necessary for the success of this restorative treatment.[17,18,21]

Endocrowns are relatively new, and few professionals feel confident about performing these procedures. Nevertheless, they are easy and quick to perform, compared with traditional single crowns with posts and cores. In this study, the proposal was to discuss the indication and use of the endocrown to replace single crowns with intraradicular retention, and present a clinical case report on the 3-year clinical follow-up of an endocrown restoration, fabricated from injected lithium disilicate ceramic (IPS e.Max Press/Ivoclar Vivadent), performed in a mandibular first molar with extensive coronal destruction from fracture.

CLINICAL CASE

A 52-year-old man attended the Dental Prosthesis Clinic at the São Leopoldo Mandic School of Dentistry and Research Center with a recent fracture on the vestibular face of the left mandibular first molar, with extensive loss of coronal tissue. The tooth had adequate interocclusal space for the fabrication of a single crown (Figure 1). The periapical radiographic exam revealed endodontically treated root canals (Figure 2). The pulp chamber was wide but not deep enough. Gingival tissue was inflamed only in the region of the fracture, but there was preserved biologic space (Figure 3).

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FIGURE 1. Initial aspect of the left mandibular first molar. Note the fracture of the vestibular face in an endodontically treated tooth. There was adequate interocclusal space.

FIGURE 2. Radiographic aspect of the initial case. Note the filled root canals.

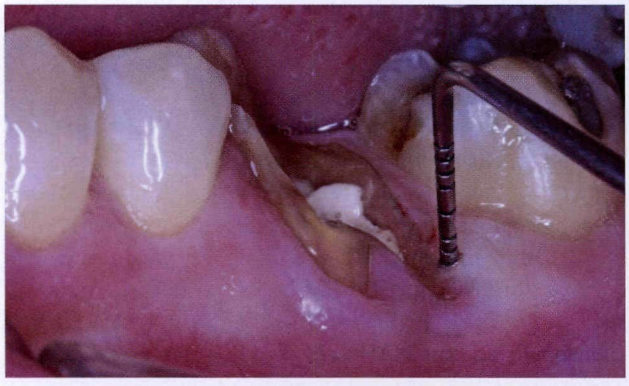

FIGURE 3. Note the preservation of the biologic space and the fracture line.

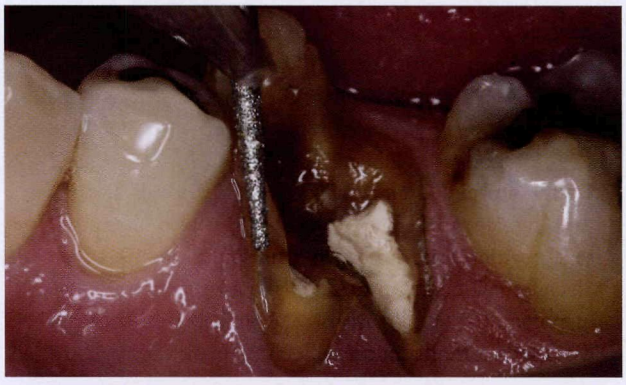

FIGURE 4. Initial cervical margin preparation using a tapered-trunk diamond-coated tip.

Although the coronal dental structure did not make it possible for a preparation to be made with all the margins in enamel, the possibilities of adhesive restorative materials (whole dentinal tissue), the quantity of dental structure present, and the partial preservation of the lingual face—thus, making it possible to provide stability to lateral masticatory forces—were considered in indicating an endocrown restoration. The preparation was adapted from the technique recommended by Bindl et al.[21] The cervical margins were leveled in the shape of a chamfer (Figure 4) with a tapered-trunk diamond-coated rounded tip #4138 (KG Sorensen, Barueri, São Paulo, Brazil), at high speed and under constant cooling, throughout the entire extension of the crown and root remainders, maintaining the lingual face terminal in enamel, with the intention of providing greater bond quality and greater retention. It was necessary to perform a gingivectomy in the disto-vestibular region of the tooth to make it easier to prepare the terminal. The entrance of the root canals was sealed with a conventional two-step adhesive system (Excite DS, Ivoclar Vivadent) and flowable resin composite (Tetric Flow, Ivoclar Vivadent, Liechtenstein, Germany). The lateral retentions of the pulp chamber walls were filled with microhybrid resin composite (Tetric Ceram, Ivoclar Vivadent). The pulp chamber was again prepared with the same diamond-coated tip to the limit

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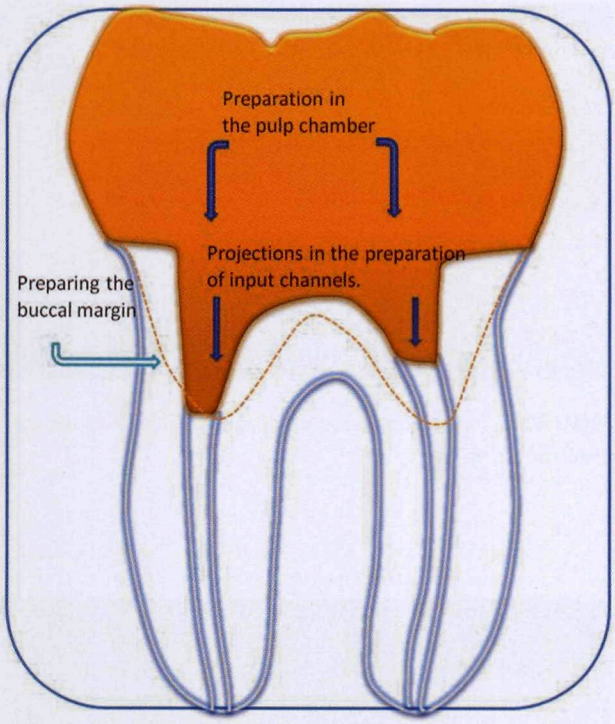

FIGURE 5. Schematic representation of the preparation for the endocrown. The dotted margin represents the preparation terminal at the vestibular margin.

of the anatomic configuration of the chamber itself with an internal taper of 8 to 10 degrees. The chamfered walls and margins were smoothed with a fine-grained tapered-trunk diamond-coated tip #4138 at low speed.

The preparation inside the pulp chamber promoted the mechanical retention and stability of the endocrown. In this clinical case, the pulp chamber was not very deep, but the presence of the whole wall on the lingual face of the tooth made it possible to obtain stability and retention. The preparation performed for making the endocrown is represented in the schematic diagram in Figure 5.

Polyvinyl siloxane silicone (Hidroxtreme, Coltène/Whaledent, Cuyahoga Falls, OH, USA) of light and heavy consistency was used with a simultaneous molding technique (Figure 6) to take the impression, together with dual retractor cord 00 and 0 (Ultrapak, Ultradent) and hemostatic gel (Vicostat, Ultradent). The temporary restoration was performed with

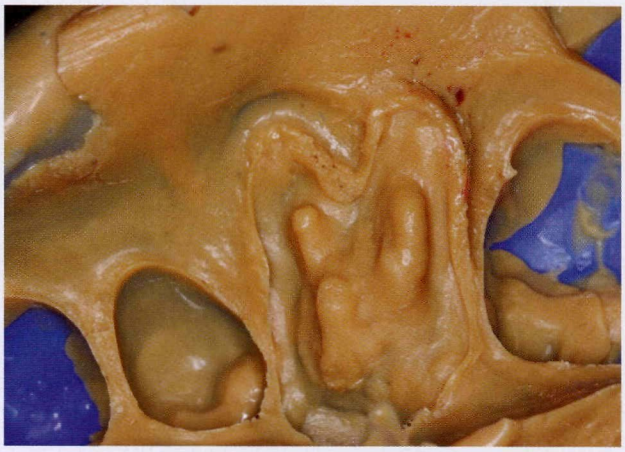

FIGURE 6. Impression made with polyvinyl siloxane material.

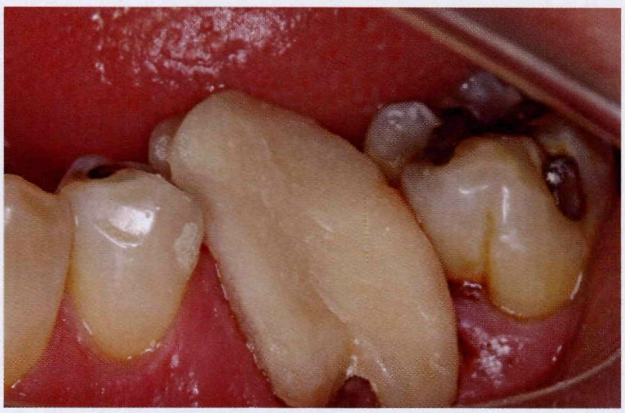

FIGURE 7. Temporary restoration made with self-polymerizing acrylic resin, with smooth and perfectly adapted cervical margins.

self-polymerizing acrylic resin (Duralay, Reliance Dental), in shade 66, with adequately adapted gingival margins to ensure healthy gingival tissue (Figure 7). The impression of the antagonist arch was taken with alginate and the casts were sent to the prosthesis laboratory with the bite registration made in self-polymerizing red acrylic resin (Duralay, Reliance Dental, Reliance Dental Manufacturing, Co., Worth, IL, USA).

The option was taken to fabricate the endocrown from lithium disilicate-based ceramic (IPS e.Max Press, Ivoclar Vivadent), in shade A2 (Figure 8). The technique consists of injecting the melted ceramic pellet into a

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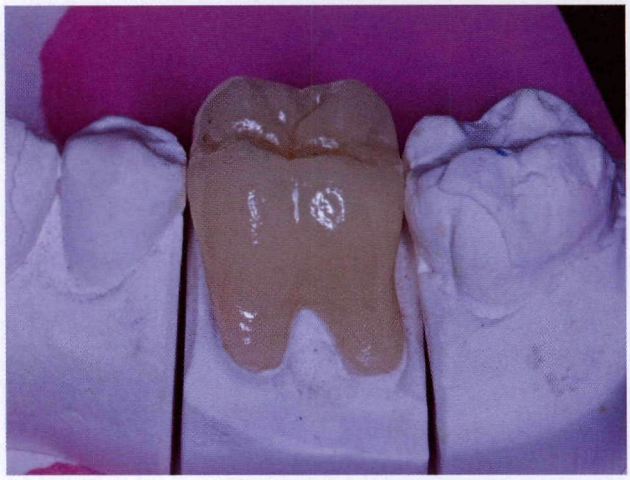

FIGURE 8. Ceramic restoration of the endocrown after conclusion of the work in the prosthesis laboratory.

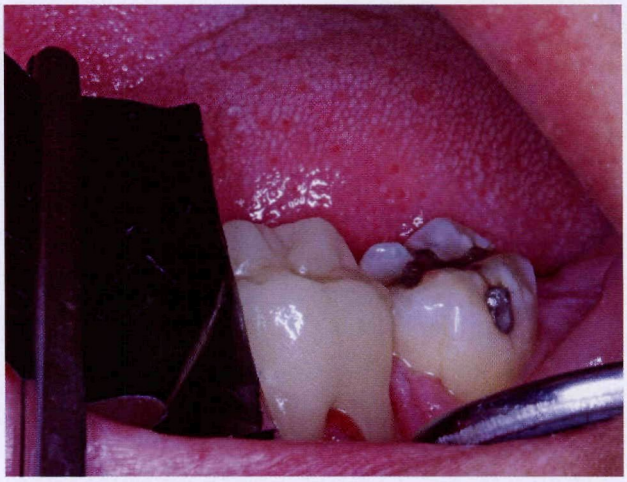

FIGURE 9. Try-in of the piece and adaptation of the restoration to determine whether adjustments are required on the proximal faces.

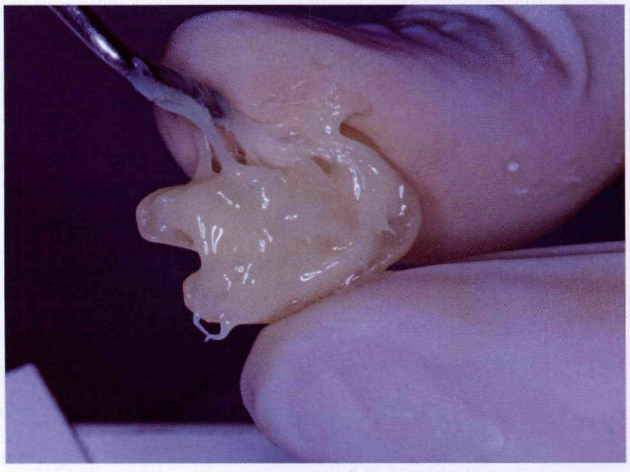

FIGURE 10. Resin cement application on the internal surface of the endocrown restoration.

lining mold fired in a furnace at a temperature of 850°C, in accordance with the manufacturer's instructions.

In the cementation session, the provisional crown was removed, and the pulp cavity and cavity margins were cleaned with pumice-water slurry, aided by a Robinson brush. The endocrown was tried-in, and small proximal adjustments were made (Figure 9). The preparation at the intrasulcular level prevented the rubber dam isolation of the operative field from being implemented. In order to control the moisture in the gingival sulcus, a retractor wire and a hemostatic solution, as well as cotton rolls and a suction device were used. The internal surface of the piece was treated in accordance with the technique recommended for lithium disilicate-based ceramics: application of 10% hydrofluoric acid (Condac, FGM) on the internal surface for 20 seconds, washing with water/air for 30 seconds, application of the silane agent (Prosil, FGM, Joinville, Santa Catarina, Brazil) for 1 minute, and application of a thin coat of the adhesive agent (Adper Scotchbond Multi-Purpose, 3M Espe, Saint Paul, MN, USA), using a disposable applicator, followed by a light air jet and light activation for 20 seconds.

The tooth was etched with 37% phosphoric acid (Villevie, Dentalville, Joinville, Santa Catarina, Brazil), for 15 seconds, with the application starting from the margins in enamel. Afterward, the tooth was washed with abundant water, and an air jet was applied for 20 seconds; the preparation was dried, keeping the dentin moist, and the activator, primer, and catalyzer of the adhesive system (Adper Scotchbond Multi-Purpose, 3M Espe) were applied, waiting 15 seconds between each application.

The chemically activated resin cement (Multilink, Ivoclar Vivadent) was spatulated for 10 seconds, and the piece was washed and placed in position on the preparation (Figure 10). The piece was pressed onto the

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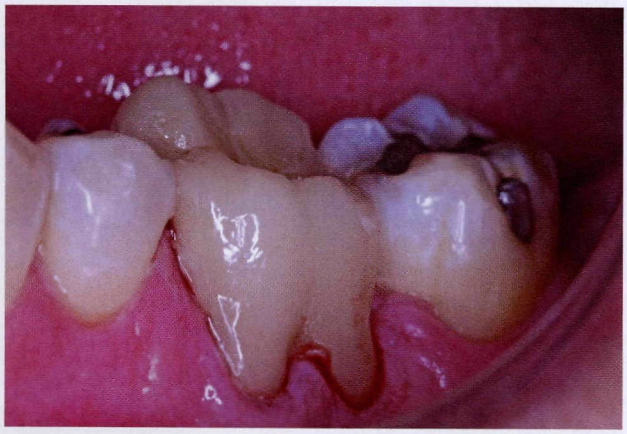

FIGURE 11. Final aspect of the cemented piece right after removing the retractor wire.

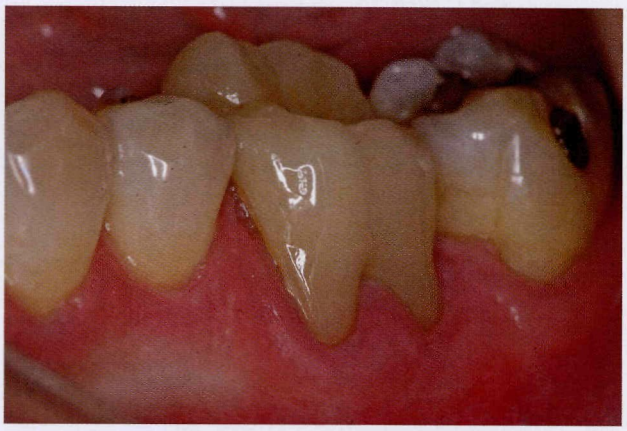

FIGURE 12. View of the endocrown 3 years after cementation.

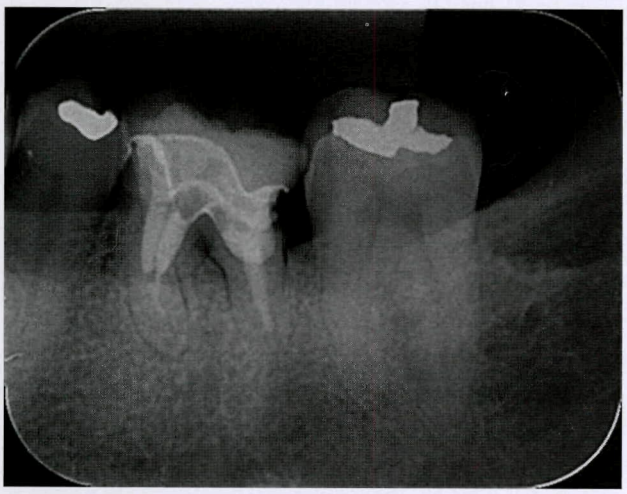

FIGURE 13. Radiographic aspect of the final case after 3 years. Note the loss of dental structure at the distal surface due to periodontal scaling and root planing. However, the endocrown restoration was well fitted in the margins, with no sign of marginal infiltration.

preparation, excess cement was removed, and light activation was performed with a light activation appliance (Radii, Southern Dental Industries, Vic., Australia), for 60 seconds on the lingual, vestibular and occlusal faces. No occlusal adjustments were necessary after cementation. Figure 11 shows the endocrown immediately after cementation. Figures 12 and 13 show the restoration after 3 years of clinical follow-up. Note the whole ceramic piece with preserved margins, healthy periodontium, and stability of the bond to tooth structure. Loss of dental structure was observed at the distal surface due to periodontal scaling and root planing. However, the endocrown piece was well fitted in the margins, with no sign of marginal infiltration.

DISCUSSION

Endocrowns appear to be a valuable option for endodontically treated posterior teeth with extensive loss of coronal structure. Studies have shown that although they are desirable for all the teeth in the arches, endocrowns should be restricted to the functional and esthetic recovery of posterior teeth, especially molars, since their performance in premolars against the action of masticatory forces has not been the same as that achieved in molars. It is believed that the smaller dental structure area of the pulp chamber and, consequently, of the adhesive surface of premolars, limits the bond strength of adhesive systems and resin cements.[21] The configuration of premolar crowns in which the height of the piece is greater than the width may create a long lever arm, increasing the risk of adhesive rupture and displacement.[21,24] However, when restricted to the posterior molar teeth, endocrowns have shown satisfactory performance in relation to the action of occlusal forces, esthetic recovery, and bond strength.[16,18–23]

The clinical procedure that involves the fabrication of these restorations, compared with the fabrication of

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crowns with cores or posts, may be considered less complex, more practical, and easier to perform. The protocol establishes a preparation with expulsive leveling of the pulp chamber walls, followed by sealing of the root canal entrances and cervical margins in a chamfer design.[21,23] Sometimes it is necessary to fill irregularities in the pulp chamber walls with resin composite in order to remove retentive areas that prevent sliding and adjustment of the piece. The internal portion of the endocrown, projected toward the inside of the pulp chamber, is responsible for the mechanical microretention.[17,18] By dispensing with the use of an intraradicular post and maintaining the seal provided by the endodontic filling material, an endocrown allows minimal tooth wear, and thus strengthens the tooth, since it helps preserve sound dental tissue and root canal structures.[9–11] In 2012, Biacchi and Basting[23] observed greater resistance to compression forces of endocrown restorations, compared with traditional crowns supported on fiber posts, when these restorations were made with lithium disilicate ceramic.

The limitation for performing this procedure may be restricted to the ceramic material, which must be an acid etchable ceramic in order to obtain the bond to tooth preparation by means of an adhesive cementation system, and, consequently, ensure stability of the piece in the preparation. Pressed or machined ceramics, especially those reinforced with lithium disilicate, appear to be the best option.[15] The lithium disilicate ceramic used to make the restorations has high mechanical strength and provides restorations with an esthetic appearance very similar to that of tooth enamel.[16]

In this clinical case, the endocrown did not meet the indications set for the technique, especially because of the lack of all preparation margins in enamel[17,18] and the need for rubber dam isolation during cementation.[25] Nevertheless, it was decided that the procedure would be performed for the following reasons: (1) the presence of the whole wall on the lingual face of the tooth, which made it possible to obtain stability and retention and (2) adhesive cementation procedures conducted in an adequate manner (controlling the moisture in the operating field and manipulating the cementation agents in accordance with the manufacturer's instructions).

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REFERENCES

1. Ree M, Schwartz R. The endo-restorative interface: current concepts. Dent Clin North Am 2010;54:345–74.
2. Hirschfeld Z, Stern N. Post and core: the biomechanical aspect. Aust Dent J 1972;17:467–8.
3. Stern N, Hirschfeld Z. Principles of preparing teeth with endodontic treatment for dowel and core restoration. J Prosthet Dent 1973;30:162–5.
4. Guzy GE, Nicholls JI. In vitro comparison of intact endodontically treated teeth with and without endo-post reinforcement. J Prosthet Dent 1979;42: 39–44.
5. Ross IF. Fracture susceptibility of endodontically treated teeth. J Endod 1980;6:560–5.
6. Assif D, Gorfil C. Biomechanical considerations in restoring endodontically treated teeth. J Prosthet Dent 1984;71:565–7.
7. Heydecke G, Butz F, Strub JR. Fracture strength and survival rate of endodontically treated maxillary incisors with approximal cavities after restoration with different post and core systems: an in vitro study. J Dent Res 2001;29:427–33.
8. Soares CJ, Santana F, Silva NR, et al. Influence of the endodontic treatment on mechanical properties of root dentin. J Endod 2007;33:603–6.
9. Asmussen E, Peutzfeldt A, Sahafi A. Finite element analysis of stresses in endodontically treated, dowel-restored teeth. J Prosthet Dent 2005;94:321–9.
10. Dietschi D, Duc O, Krejci I, et al. Biomechanical considerations for the restoration of endodontically treated teeth: a systematic review of the literature, part II (evaluation of fatigue behavior, interfaces, and in vivo studies). Quintessence Int 2008;39:117–26.
11. Zarow M, Devoto W, Saracinelli M. Reconstruction of endodontically treated posterior teeth—with or without post? Guidelines for the dental practitioner. Eur J Esthet Dent 2009;4:312–27.

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12. Ma OS, Nicholls JI, Junge T, et al. Load fatigue of teeth with different ferrule lengths, restored with fiber posts, composite resin cores, and all-ceramic crowns. J Prosthet Dent 2009;102:229–34.
13. Raymond C, Payant L. In vitro fracture strength evaluation of ceramic endo-crowns with an In-Ceram core [text on the internet]. 2004. Available at: http://www.yasni.info/ext.php?url=http%3A%2F%2Fwww.fmd.ulaval.ca%2Fckfinder%2Fuserfiles%2Ffiles%2F2004-11.pdf&name=Claude+Raymond&showads=1&lc=en-ca&lg=en&rg=ca&rip=ca.fmd.ulaval.ca/documents/journees_2004/11pdf (accessed October 11, 2013)
14. Leirskar J, Nordbù H, Thoresen NR, et al. A four to six year follow-up of indirect resin composite inlays/onlays. Acta Odontol Scand 2003;61:247–51.
15. Tysowsky GW. The science behind lithium disilicate: a metal-free alternative. Dent Today 2009;28:112–13.
16. Pissis P. Fabrication of a metal-free ceramic restoration utilizing the monobloc technique. Pract Periodontics Aesthet Dent 1995;7:83–94.
17. Bindl A, Mörmann WH. Clinical evaluation of adhesively placed Cerec endocrowns after 2 years—preliminary results. J Adhes Dent 1999;1:255–65.
18. Göhring TN, Peters AO. Restoration of endodontically treated teeth without posts. Am J Dent 2003;16:313–18.
19. Bernhart J, Bräuning A, Altenburger MJ, et al. Cerec3D endocrowns—two-year clinical examination of CAD/CAM crowns for restoring endodontically treated molars. Int J Comput Dent 2010;13:141–54.
20. Otto T. Computer-aided direct all-ceramic crowns: preliminary 1-year results of a prospective clinical study. Int J Periodontics Restorative Dent 2004;24:446–55.
21. Bindl A, Richter B, Mörmann WH. Survival of ceramic-computer-aided/manufacturing crowns bonded to preparations with reduced macroretention geometry. Int J Prosthodont 2005;18:219–24.
22. Lander E, Dietschi D. Endocrown: a clinical report. Quintessence Int 2008;39:99–106.
23. Biacchi GR, Basting RT. Comparison of fracture strength of endocrowns and glass fiber post-retained conventional crowns. Oper Dent 2012;37:130–3.
24. Valentina V, Aleksandar T, Dejan L, et al. Restoring endodontically treated teeth with all-ceramic endo-crowns—case report. Serbian Dent J 2008;55:54–64.
25. Chaio C, Kuo J, Lin Y, et al. Fracture resistance and failure modes of CEREC endo-crowns and conventional post and core-supported CEREC crowns. J Dent Scie 2009;4:110–1727.

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