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| REVIEW

Endocrown as a restorative strategy in endodontically treated teeth: an integrative literature review

Endocrown como estratégia restauradora em dentes tratados endodonticamente: uma revisão integrativa da literatura

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ABSTRACT

With the consolidation of Adhesive Dentistry and the emergence of new aesthetic restorative materials, Endocrown has been studied as a rehabilitative option for endodontically treated teeth. This is an Integrative Literature Review, based on the PICO strategy, with articles selected from the databases of PubMed and BVS, with a period of time from 2011-2021. The database search strategy included the following keywords: ("Endocrown" OR "Endocrowns" OR "Endocrown Restoration" OR "no-post buildup" OR "adhesive endodontic crowns"). Inclusion criteria for this review were laboratory studies and observational clinical studies. Exclusion criteria were clinical case studies, literature review, systematic review and meta-analysis. Furthermore, articles that addressed only intraradicular retainers or other restorative strategies were also excluded. The selection of articles was based on abstracts. 5 articles were selected for analysis, obtaining data on the endocrown in relation to the stress on the tooth structure, aging, marginal adaptation, fracture resistance, endocrown versus conventional crown and integrity of the tooth structure. The findings in the literature are not yet established regarding the integrity of the dental structure, as the supporting evidence is limited. Only 1 in vitro article showed that dental failures in endocrowns are more favorable to repair and another 2 in silico studies show lower stress distribution on enamel, dentin and cement in the same restoration. Moreover, the restorative material seems to influence the possibility of fracture for both conventional crowns and endocrown restorations.

Indexing terms: Adhesives. Dental prosthesis. Crowns. Endodontics. Longevity.

RESUMO

Com a consolidação da Odontologia Adesiva e o surgimento de novos materiais restauradores estéticos, a Endocrown vem sendo estudada como uma opção reabilitadora para dentes tratados endodonticamente. Trata-se de uma Revisão Integrativa da Literatura, baseada na estratégia PICO, com artigos selecionados nas bases de dados da PubMed e BVS, com lapso temporal de 2011-2021. A estratégia de busca nas bases de dados foi utilizando as palavras chaves: ("Endocrown" OR "Endocrowns" OR "Endocrown Restoration" OR "no-post buildup" OR "adhesive endodontic crowns"). Os critérios de inclusão nesta revisão foram estudos laboratoriais e estudos

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clínicos observacionais. Os critérios de exclusão foram estudos de caso clínico, revisão de literatura, revisão sistemática e metanálise. Ademais, também foram excluídos artigos que abordavam apenas retentores intrarradiculares ou outras estratégias restauradoras. A seleção dos artigos foi realizada com base nos resumos. 5 artigos foram selecionados para análise, obtendo-se dados sobre a endocrown em relação à tensão sobre a estrutura dental, envelhecimento, adaptação marginal, resistência à fratura, endocrown versus coroa convencional, integridade da estrutura dental. Os achados da literatura ainda não estão estabelecidos em relação a integridade da estrutura dental, devido às evidências de apoio serem limitadas. Apenas 1 artigo in Vitro apresentou que as falhas dentais em endocrowns são mais favoráveis ao reparo e outros 2 estudos in Silico mostram menor distribuição de tensão sobre esmalte, dentina e cemento na mesma restauração. Além disso, o material restaurador parece influenciar a possibilidade de fratura tanto para as coroas convencionais quanto para as restaurações do tipo endocrowns.

Termos de indexação: *Adesivos. Prótese dentária. Coroas. Endodontia. Longevidade.*

INTRODUCTION

One of the most frequent clinical problems faced by dentists refers to endodontically treated teeth with extensive coronary destruction, in which aesthetic and functional recovery is complex. For many years, the confection of a total crown retained by an intraradicular pin has been the main restoration option for these cases [1,2]. However, the right way to restore teeth after endodontic treatment remains a controversial topic in the literature, as these teeth have significantly lower mechanical properties compared to vital teeth [3,4].

Endodontically treated teeth have reduced structural integrity due to the dental pulp removal procedure and instrumentation. In cases of severely damaged elements in the coronary region, fixed crowns with intraradicular retainers (set) are recommended. However, studies have shown that this set makes the dental elements more susceptible to root fracture, when exposed to greater masticatory stresses [5].

The application of pins can cause weakening of the roots, in addition to the risk of perforation during root canal preparation [6]. So pins, cores and crowns have several contraindications for their use, and therefore, the dentist needs to have other alternatives when choosing the restoration [7], such as the use of endocrowns [6].

Studies show that Endocrown has good performance regarding mechanical strength and fracture behavior and that resin-based restorative materials for this type of restoration seem to be interesting alternative options for manufacturing large dental restorations [8]. And with the development of adhesive systems, the need for intraradicular anchorage has been reduced. Currently, Endocrown has been seen as an adequate alternative for these cases [9].

The consolidation of Adhesive Dentistry and the emergence of new aesthetic restorative materials [4] contributed to opening up new restorative possibilities for endodontically treated teeth. Started with the gradual replacement of metal cores by fiberglass posts, however catastrophic failures also persist in this restorative condition. Alternatively, non-pin approaches have been proposed in order to improve the chances of dental repair in cases of extensive loss of coronary structure [3,4,10]. This approach refers to the adhesive endodontic crown, also called endocrown restorations, as an option to restore endodontically treated molars with extensive loss of coronal structure and/or in cases that prevent the placement of pins, such as obstructed pulp canals, curved or short and small crowns [10].

Additionally, the development of CAD/CAM (Computer-aided Design / Computer-aided Manufacture) technology opened new horizons, both in material processing and in tooth restoration, providing precision, aesthetics and less time-consuming restorative procedures [11]. With the advent of this technology, endocrown restorations allow them to be milled using CAD/CAM technology, which minimizes clinical adjustment procedures and the incorporation of defects during preparation, in addition to allowing the treatment to be performed in a single session [12].

Hence, Endocrowns have many advantages, such as: better mechanical performance, low cost and shorter clinical time to complete the endocrown, in relation to the fixed crown with a pin [10]. Several studies have been proposed to evaluate the performance of these restorations [3,5,10,13,14]. A retrospective clinical study evaluated the longevity of 11 endocrowns installed in a private clinic over a period of 8 to 19 years. These restorations were made with metallic alloy, resin material and ceramic, hence it was found that 10 (90.9%) endocrowns were in function and 1 failed (9.1%) due to periodontal disease, the average survival time was 12 years and 3 months. Finally, the success criteria on the quality of the restorations were: Excellent 5 (50%), Good 4 (40%) and Functional Survival 1 (10%) [13].

Lastly, Endocrowns require an oriented dental preparation, taking advantage of the adhesion and retention of the pulp chamber walls. They are strongly indicated for endodontically treated posterior teeth, especially in cases where the interocclusal space is minimal and the presence of curved or narrow root canals [15].

Nevertheless, there are still gaps regarding the biomechanical behavior on tooth structure, in order to extrapolate the data to daily clinic [3]. Based on the above, the objective was to review the literature in an integrative way on endocrown restorations as a restorative strategy in endodontically treated teeth.

METHODS

Guiding question

The guiding question for the following study was: "Is endocrown a restorative strategy that favors the integrity of the tooth structure compared to conventional treatments (fixed pin and crown and inlay) in endodontically treated teeth?

Method

This study refers to an Integrative Literature Review that synthesizes the available research on the subject to be addressed and directs the practice based on scientific knowledge, with the research structuring based on the PICO strategy. The PICO strategy of this review was guided by the following elements: "Population" patients with endodontically treated teeth in need of restoration; "Intervention" through Endocrown, "Control" would be conventional treatments (fixed pin and crown, direct restoration in composite resin, onlay, inlay) and the "Outcome" greater longevity of the tooth structure.

Eligibility criteria

This literature review presented as search strategy the in the following databases: Biblioteca Virtual em Saúde (https://bvsalud.org/) and PubMed (https://pubmed.ncbi.nlm.nih.gov/). Articles published in Portuguese and English, between 2011 to 2021, with the last survey conducted on May 5, 2021. The descriptors used were searched by reading the title and abstract, since "Endocrown" and similar are not present in Desc and Mesh; therefore, it was possible to filter the studies aimed at the restoration in question. The database search strategy was ("Endocrown" OR "Endocrowns" OR "Endocrown Restoration" OR "no-post buildup" OR "adhesive endodontic crowns"). The inclusion criteria in this review were laboratory studies and observational clinical studies that addressed the restoration in question. Exclusion criteria were clinical case studies, narrative literature review, opinion article, articles not available in the databases. Furthermore, articles that address only intraradicular retainers, other restorative strategies or there is no comparison between conventional treatments and the restoration under study were also excluded. The selection of articles was based on abstracts.

Study selection

The titles and abstracts of all works were analyzed by three reviewers. All studies that met the inclusion criteria were selected for full text reading and included for data extraction, while the reasons for exclusion were recorded. The search strategy of this study is detailed in figure 1.

Data extraction

The complete data of the selected texts were extracted by the reviewers. Data collection was based on results regarding the use of Endocrown as a restorative strategy for endodontically treated teeth.

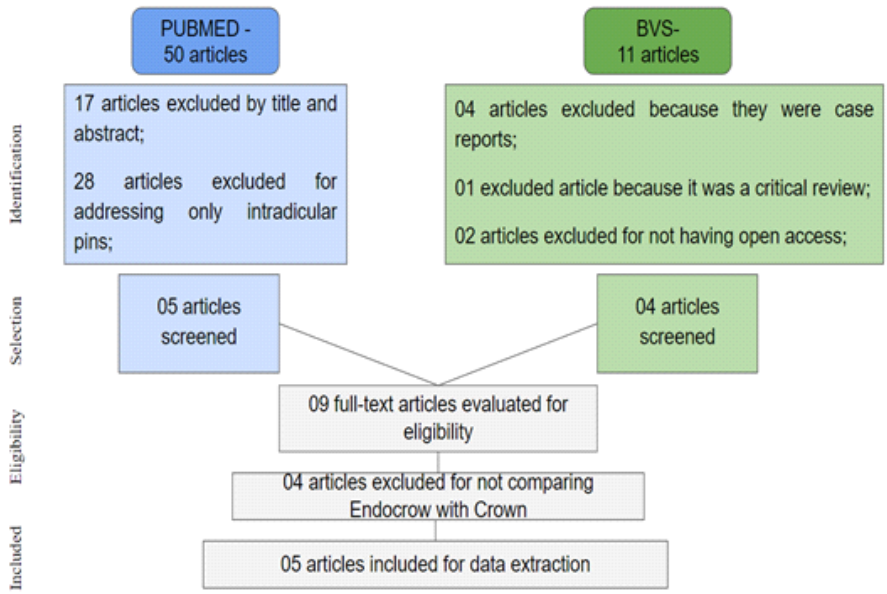

Figure 1. Selection of articles for integrative review.

Table 1. Author (year), Grade of Recommendation and Level of Evidence according to the Oxford Level of Evidence [16] of the studies selected for review.

Author (year)	Grade of Recommendation	Level of Evidence
Lin et al. [3]	B	2C
Biacchi & Basting (2012) [10]	B	2C
Ramírez-Sebastià et al. (2013) [17]	B	2C
Alghalayini et al. (2020) [18]	B	2C
Li et al. (2020) [5]	B	2C

Data analysis

The data were collected and included in table 2, the extraction of data from the included surveys was done by creating a standardized table in Excel with the following information: Author (year), Objective, Type of Study, Method, Experimental Groups, Dental Elements, Ferrule, Restoration Material, Aging. The level of scientific evidence was based on the classification of the "Oxford Center for Evidence-based Medicine", cited in the article by Demathé et al. [16] observed in table 1. The extraction of all data was performed by the three reviewers and from the data obtained, tables were created in order to summarize the information.

RESULTS

Studies included in the review

Combining the search methods, 61 articles were identified in the databases. After applying the exclusion criteria, a total of 05 articles resulted for review. Figure 1 exemplifies the articles selection in the BVS and PubMed. All reviewed studies are shown in table 2, table 3, table 4, and the grade of recommendation (level of evidence) is shown in table 1.

Table 2. Author (year), Objective, Type of Study, Method, Experimental Groups, Dental Elements, Ferrule, Restoration Material, Aging.

Author (year)	Objective	Type of Study	Method	Experimental Groups	Aging
Lin et al. (2011) [3]	To evaluate the risk of failure in endodontically treated premolars with MOD preparation and three restorative possibilities (inlay, endocrown and conventional crown)	In Silico In Vitro	3D finite element models designed with CEREC to produce restorations: Inlay, Endocrown, Conventional Crown with Metal Pin. The failure probability was calculated according with the Weibull statistic analysis. The fracture strength and the corresponding load value of the first acoustic emission (EA) activity in each sample were recorded by means of compression tests of restored teeth	Group I: Inlay; Group E: Endocrown; Group C: Conventional Crown	-
Biacchi & Basting (2012) [10]	To compare the fracture resistance of ceramic restorations using two techniques: crowns retained by glass fiber pins and endocrowns and check Fracture standard.	In Vitro	20 dental elements were divided into two groups (n = 10). The teeth were treated endodontically and prepared for ceramic restorations fabricated by the injection technique. The compression to fracture test was performed simulating an oblique force condition.	Group Endocrown (GE) Group Conventional Crown (GC)	-
Ramírez-Sebastià et al. (2013) [17]	To compare the marginal adaptation between ceramic and resin restorations in endodontically treated teeth restored with endocrowns, with short pin or long pin.	In Vitro	Forty-eight intact dental elements were used. The teeth were treated endodontically and had the crowns sectioned 2 mm from the crown above the cemento-enamel junction. The specimens were randomly divided into 6 groups (n=8). The specimens were aged in thermomechanical loading. Impressions of each restoration were made on a polyvinylsiloxane material before and after loading. Gold-coated epoxy replicas were prepared for scanning electron microscopy examination at magnification to evaluate marginal adaptation across the external adhesive interface.	Group 1 (LPCer)- long fiber pin + ceramic crown; Grupo 2 (SPCer)- short fiber pin + ceramic crown; Grupo 3 (LPCpr)- long fiber pin + resin crown; Grupo 4 (SPCpr)- short fiber pin + resin crown; Grupos 5 e 6 (ENDOcer e ENDOcpr) – endocrow ceramic and endocrown resin, respectively.	Thermomechanical Loading
Alghalayini et al. (2020) [18]	To evaluate the ability of nanoceramic resin to withstand occlusal forces when used in the anterior region through full crowns and endocrowns;	In vitro	Eighty endodontically treated dental elements were used and divided into experimental groups (n=10); All restorations were performed using the CAD/ CAM system (Cerec MCXL). All samples were subjected to cyclic fatigue tests to identify cracks until fracture and Fracture toughness;	Group 1: pin + crown e Group 2: endocrown. Subgroup A: IPS e.max (Ivoclar, Schaan, Liechtenstein) e subgroup B: Lava Ultimate (3M ESPE, St. Paul, EUA).	Mechanical Loading (100.000 Loading)
Li et al. (2020) [5]	To analyze the stress distribution of maxillary central incisors with oblique fracture repaired by different restorative methods using three-dimensional finite element analysis.	In Silico	Use of Cone-Beam Computed Tomography and finite element software to establish finite element models of the maxillary central incisor with oblique fracture. Models were created according to 5 repair methods/experimental groups. After root canal treatment, the equivalent Von Mises stress and the maximum principal stress distribution and peak value of each model were analyzed.	A. Fiber Pin + Crown; B. Metal Pin + Crown; C. Endocrown (3mm depth); D. endocrown (4mm depth); E. endocrown (5mm depth).	-

Table 3. Author (year), Dental Elements, Ferrule, Restoration Material.

Author (year)	Dental Elements	Ferrule	Restoration Material
Lin et al. (2011) [3]	Premolars	1mm above the cemento-enamel junction	Ceramic- Leucita (Vita Mark II, Vita, Germany)
Biacchi & Basting (2012) [10]	Lower Molar	1mm above the cemento-enamel junction	Ceramic – Lithium Disilicate (IPS e.max Press, Ivoclar-Vivadent, Germany)
Ramírez-Sebastià et al. (2013) [17]	Maxillary central incisor	2mm above the cemento-enamel junction	Resin (Paradigm MZ100, 3M ESPE, USA) Ceramic – Leucita (IPS Empress CAD, Ivoclar Vivadent, Germany)
Alghalayini et al. (2020) [18]	Maxillary central incisor	0,5 mm or 2 mm above the cemento-enamel junction	Ceramic - Lithium Disilicate (IPS e.max Press, Ivoclar-Vivadent, Germany) Nanoceramic Resin Lava Ultimate (3M ESPE,USA)
Li et al. (2020) [5]	Maxillary central incisors	The tooth height at the cemento-enamel junction was defined as 0 mm. Mesial-distal height tooth is: 1 to 0 mm, 2 to 0 mm	Ceramic - Lithium Disilicate

Stress on tooth structure

The stress values in premolars on enamel, dentin and cement for endocrowns restorations were the lowest compared with the inlay and the conventional crowns, by data obtained through In Silico study [3]. As also, in Li et al. [5] the stress on the crown promoted root fracture, while the endocrown only fracture of the restorative material. However, the ferrule effect influences this scenario for both restorations.

Aging

Central incisors restored with conventional crowns and endocrowns survived thermomechanical loading without loss of retention or fracture [17]. The same dental element in the study by Alghalayini et al. [18] demonstrated cracks in both restorations with the number of these failures being high throughout loading. The presence of the cracks were more frequent in the ceramic material than in the nanoceramic resin.

Marginal Adaptation

The adaptation of the external adhesive interfaces in conventional crown and endocrown was significant ($p < 0.05$) for the effect of the test (before and after aging) and the effect of the restorative material. Prior to aging, the continuity at the tooth-cement interface was greater than 90%, no significant differences between the different groups ($p = 0.062$). A trend of better behavior of the restorations with the resin material compared than ceramic material [17].

Table 4. Author (year) and Fracture Standard.

Author (year)	Fracture Standard
Lin et al. (2011) [3]	The Weibull analysis indicated that the failure probability was 95%, 2% and 2% for the inlay, endocrown and conventional crown respectively, under normal masticatory load; The probabilities of failure distributions showed that the three restorations exhibit the same probability of failure as the ceramic; Enamel, dentin and cement failures are significantly higher for inlay than for endocrown and conventional crowns; The overall failure probability showed that the endocrown and conventional crowns performed almost equally;
Biacchi & Basting (2012) [10]	A high prevalence of fracture in the tooth or restoration with decementation of the restoration for both GC 80% and CE 90% groups. It was observed that tooth fractures occurred on the side where the test force was applied, and decementation occurred on the opposite side; Conventional crown fracture located at the cuspid (10%) Group CG; Root tooth fracture at the apical 1/3 (10%) Group EG; Decementation without fracture (10%) Group CG;
Ramírez-Sebastià et al. (2013) [17]	None of the samples suffered from loss of retention or fracture; Dentin cracks could be observed in samples restored with ceramics, while no cracks were evident in the dentin when resin material was adopted;
Alghalayini et al. (2020) [18]	Crowns with the 2.0 mm ferrule showed a higher risk of fracture than endrocrowns with the1.0 mm ferrule during loading; The material was the main influencing factor on crack formation, IPS e.max showed a higher number of cracks in comparison then Lava Ultimate; Endocrowns proved to be more repair-friendly (fracture did not extend beyond the cementoenamel junction) than conventional pin and crown restorations; Dental elements with 0.5 mm ferrule were more restorable than those with 2 mm. Lava Ultimate crowns with 2 mm (0%) had the worst restorable capacity, IPS e.max Endocrown with 2 mm had the best restorable potential (100%);
Li et al. (2020) [5]	The stress applied in the endocrown groups result in crown fracture, while in the groups with conventional crown, root fracture would result.

After loading, statistically significant differences were observed between restorations with the resin material (LPCpr, SPCpr, and EndoCpr) and the ceramic material (LPCer, SpCer, and EndoCer) ($p = 0.0001$). The performance of ceramic restorations at the marginal adaptation level was significantly lower, regardless of the type of retention that was used (pin or endocrown) [17].

Fracture strength

The compression test showed no significant differences ($p > 0.05$) in premolars between the restorations (endocrown, inlay, crown). The first acoustic emission (AE) differed significantly ($p < 0.05$) for the three restorations. Low loading was observed for the first acoustic emission (AE) of the inlay compared to endocrown and conventional crown, the latter restorations did not differ significantly regarding the loading for AE [3]. In the study by Biacchi and Basting [10] Endocrown in molars proved to be more resistant to compressive forces than conventional crown ($p = 0.002$). Whereas for incisors, the restorative strategy (endocrown or conventional crown) and ferrule effect was not shown to be statistically significant ($p>0.05$). While the restorative material was significant ($p<0.01$) during static loading, nanoceramic resin showed higher load-to-fracture values than ceramic [18].

Endocrown versus Conventional Crown

Endocrown and conventional crown for endodontically treated incisors [18] and premolars [3] show similar mechanical strength results, so Endocrown should be considered as an alternative to conventional treatment [3,18]. The findings of Biacchi and Basting [10] from mechanical strength data, consider Endocrown as a restorative strategy for

endodontically treated molars with extensive coronal destruction capable of replacing conventional pin-supported crown. Finally, marginal adaptation research shows similarities between the performance of conventional crowns with long and short pins and Endocrowns for maxillary central incisors [17].

Dental Framework Integrity

The integrity of tooth structure, in relation to the restorative strategy, does not seem to be significant in the studies of Biacchi and Basting [10] and Ramírez-Sebastià et al. [17], as there was a balance regarding the fracture and failure scenario is perhaps due to the restorative material, respectively. In the study by Alghalayini et al. [18] endocrowns were shown to be more repair-friendly than conventional pin and crown restorations, however the restorative material seems to have an influence on the longevity of the tooth structure.

DISCUSSION

From a biomimetic perspective, the preservation and conservation of the tooth structure are essential for maintaining the balance between biological, mechanical, adhesive, functional and aesthetic factors of the dental element to be restored [4]. The findings of this review showed through in vitro studies that there is similar compressive strength between endodocrown and conventional crown [3,18], or even higher for the first restoration [10] for anterior and posterior teeth. Perhaps the different results can be explained by the limitations of in vitro tests, which in an attempt to produce the mechanisms responsible for the occurrence of failures may not necessarily reflect the clinical performance of the restorations [10].

The superiority of fracture resistance observed in the study by Biacchi and Basting [10] is perhaps due to the greater thickness of the restoration in the GE Group than in the GC Group, thus the high bond between the ceramic material (lithium disilicate) and dental structure, in addition to the smaller number of bonding interfaces, it will form a more resistant dentin / enamel / ceramic set when compared to the dentin / enamel / post / resin / ceramic present in the conventional crown [10]. Adhesive restorations are mainly based on bond capacity and do not require macro-retentive elements [17]. The anatomical or non-anatomical design of the endocrown is also a factor that can interfere with endocrown fractures in upper premolars and should be further investigated [14].

The restorative material is also an important variable to be investigated, as it seems to interfere with dental integrity, according to the researched literature [17,18]. Results that corroborate with other researches, endocrowns made of resin restorative materials can result in less aggressive failures. Vita Enamic endodontic crowns proved to be more resistant to fracture than IPS e.max samples and with less dental damage [14]. Lithium disilicate endocrowns have less stress-bearing ability, failing early and under less load when compared to resin-based material endocrowns [15]. Resilient material has less surface failure and higher fracture load values, thus leading to more catastrophic failure and less restorative capacity [18]. Another study presents a counterpoint in the literature, lithium disilicate ceramic endocrowns exhibit greater fracture resistance than indirect composites, however composite endocrowns showed more favorable repair failure than ceramic endocrowns [14].

According to the dental structure, the amount of ferrule is a requirement to repair upper central incisor with excessive defect, in the presence of incomplete remnant the endocrown stress distribution is better than crown and pin [5], which corroborates with the findings by Alghalayini et al. [18]. However, the finite element method cannot really simulate the complex situation in the mouth, analyzing only an ideal stress situation, static load, but in the chewing process itself it has a dynamic load, which will affect the accuracy of the results [5]. The balance of dental structure failures in the study by Biacchi and Basting [10] can be explained by the oblique load applied during the mechanical test. Therefore, an extreme situation generates catastrophic failure regardless of the type of restoration.

The limitations of this review are the scientific evidence from in vitro and in silico studies, most of which do not present long-term data (aging), so conclusions drawn from this in vitro study must be confirmed by controlled

clinical trials before they are applied as routine clinical work recommendations [17]. New controlled clinical studies will be important to consolidate, in the long term, the use of this restorative strategy in endodontically treated teeth.

CONCLUSION

The present integrative literature review, regarding Endocrown as a restorative strategy in endodontically treated teeth, noted that the findings in the literature are not yet established in relation to the integrity of the tooth structure, due to limited supporting evidence. Only 01 in vitro article showed that dental failures in endocrowns are more favorable to repair and another 02 in silico studies show lower stress distribution on enamel, dentin and cement in the same restoration. Furthermore, the restorative material seems to influence the possibility of fracture for both conventional crowns and endocrown restorations.

Collaborators

QUEIROZ ACS, GOMES RL and FIGUEIREDO VMG determined the PICO strategy, searched the literature, extracted the data, analyzed the data and wrote the article.

REFERENCES

1. Menezes-Silva R, Espinoza CAV, Atta MT, Navarro MFL, Ishikiriama SK, Mondelli RFL. Endocrown: a conservative approach. Braz Dent Sci. 2016;19(2). https://dx.doi.org/10.14295/bds.2016.v19i2.1156
2. Houda D, Feriel A, Adel A, Nabiha D. Endocrown: an alternative approachfor restoring endodontically treated molars with large coronal destruction. Case Rep Dent. 2018;2018:1581952. https://dx.doi.org/10.1155/2018/1581952
3. Lin CL, Chang YH, Pai CA. Evaluation of failure risks in ceramic restorations for endodontically treated premolar with MOD preparation. Dent Mater. 2011;27(5):431-8. https://dx.doi.org/10.1016/j.dental.2010.10.026
4. Carvalho MA, Lazari PC, Gresnigt M, Del Bel Cury AA, Magne P. Current options concerning the endodontically-treated teeth restoration with the adhesive approach. Braz Oral Res. 2018;32(Suppl 1): 147-158. https://doi.org/10.1590/1807-3107bor-2018.vol32.0074
5. Li X, Kang T, Zhan D, Xie J, Guo L. Biomechanical behavior of endocrowns vs fiber post-core-crown vs cast post-core-crown for the restoration of maxillarycentral incisors with 1mm and 2 mm ferrule height: A 3D static linear finite element analysis. Medicine. 2020;23;99(43). https://dx.doi.org/10.1097/MD.0000000000022648
6. Kanat-Ertürk B, Saridağ S, Köseler E, Helvacioğlu-Yiğit D, Avcu E, Yildiran-Avcu Y. Fracture strengths of endocrown restorations fabricated with different preparation depths and CAD/CAM materials. Dent Mat J. 2018;37(2):256-265. https://dx.doi.org/10.4012/dmj.2017-035
7. Irmaleny, Zuleika, Ardjanggi S, Mardiyah AA, Wahjuningrum DA. Endocrown restoration on postendodontics treatment on lower first molar. J Int Soc Prev Community Dent. 2019;9(3):303-310. https://dx.doi.org/10.4103/jispcd.JISPCD_399_18
8. Sedrez-Porto JA, Münchow EA, Cenci MS, Pereira-Cenci T. Which materials would account for a better mechanical behavior for direct endocrown restorations? J Mech Behav Biomed Mater. 2020;103:103592. https://dx.doi.org/10.1016/j.jmbbm.2019.103592
9. Gupta R, Thakur S, Pandey NK, Roopa B, Fares KT. Endocrown - A Paradigm Shift in Rehabilitation: a report of two cases. Contemp Clin Dent. 2021;12(2):195-198. https://dx.doi.org/10.4103/ccd.ccd_557_20
10. Biacchi GR, Basting RT. Comparison of Fracture Strength of Endocrowns and Glass Fiber Post Retained Conventional Crowns. Oper Dent. 2012; 37(2):130-6. https://dx.doi.org/10.2341/11-105-L
11. Tzimas K, Tsiafitsa M, Gerasimou P, Tsitrou E. Endocrown restorations for extensively damaged posterior teeth: clinical performance of three cases. Restor Dent Endod. 2018;43(4):e38. https://dx.doi.org/10.5395/de.2018.43.e38
12. Tribst JPM, Dal Pivaa AMO, Madrugaa CFL, Valerab MC, Borgesa ALS, Brescianib E, et al. Endocrown restorations: Influence of dental remnant and restorative material on stress distribution. Dent Mater. 2018;34(10):1466-1473. https://dx.doi.org/10.1016/j.dental.2018.06.012
13. Botto EB, Barón R, Botto, JLB. Endocrowns: a retrospective patient series study, in an 8-to-19-year period. Odontoestomatología. 2016;18(28): 45-56.
14. Altier M, Erol F, Yildirim G, Dalkilic EE. Fracture resistance and failure modes of lithium disilicate or composite endocrowns. Niger J Clin Pract. 2018;21:821-6. https://dx.doi.org/10.4103/njcp.njcp_175_17

15. Sedrez-Porto JA, Münchow EA, Valente LL, Cenci MS, Pereira-Cenci T. New material perspective for endocrown restorations: effects on mechanical performance and fracture behavior. Braz Oral Res. 2019;11;33:e012. https://dx.doi.org/10.1590/1807-3107bor-2019.vol33.0012

16. Alghalayini S, Ebeid K, Aldahrab A, Wahsh M. Fracture load of nano-ceramic composite material for anterior endocrown restorations. Braz Dent Sci 2020;23(1). https://dx.doi.org/10.14295/bds.2020.v23i1.1853

17. Foad A, Hamdy A, Fatah GAE, Aboelfadl A. Influence of CAD/CAM material and preparation design on the long-term fracture resistance of endocrowns restoring maxillary premolars. Braz Dent Sci 2020;23(4). https://dx.doi.org/10.14295/bds.2020.v23i4.2060

18. Papalexopoulos D, Samartzi TK, Sarafianou A. A Thorough analysis of the endocrown restoration: a literature review. J Contemp Dent Pract. 2021;22(4):422-426.

19. Demathé A, Silva ARS, De Carli J, Goiato MC, Miyahara GI. Odontologia baseada em evidências: otimizando a prática e a pesquisa. Rev Fac Odontol - UPF. 2012;17(1):1-10. https://dx.doi.org/10.5335/rfo.v17i1.2549

20. Ramírez-Sebastià A, Bortolotto T, Roig M, Krejci I. Composite vs ceramic computer-aided design/computer-assisted manufacturing crowns in endodontically treated teeth: analysis of marginal adaptation. Oper Dent. 2013;38(6):663-73. https://dx.doi.org/10.2341/12-208-L

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