Are the Endocrowns Better than the Conventional crowns as a Restoration of Posterior Endodontically Treated Teeth?  
A Systematic Review

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ABSTRACT

Background: Restoration of endodontically treated teeth with extensive coronal loss has always followed a strict protocol, with the fabrication of total crowns supported on metal cores and/or glass fiber posts, it was believed that this procedure would provide better reinforcement of the remaining dental structure. With the advent of adhesive dentistry moreover, the appearance of ceramics that had high strength and were capable of being acid etched (such as those reinforced with leucite or lithium), made it possible to restore posterior teeth, especially molars, without cores and intraradicular posts, this restoration called Endocrown which is a total porcelain crown fixed to a devitalized tooth, which is anchored to the internal portion of pulp chamber and cavity margins, thus obtaining macromechanical retention (provided by the pulpal walls) and micoretention (by using adhesive cementation).

Objective: the purpose of this study to compare the Endocrown with fiber post, core and conventional crown in restoring posterior endodontically treated teeth.

Material and Methods: the collected data were systematically reviewed the previous randomized control trails that compared the Endocrown with fiber post, core and conventional crown as endodontically posterior teeth. Eight randomized control trails matched our inclusion criteria, six of them compared the fracture resistance of both restorations and two papers compared the marginal fitness.

Results: from the collected data we found the ceramic Endocrowns showed a significantly higher fracture resistance than the classic strength than indirect conventional crowns associated with glass fiber posts and resin composite filling cores, onlays and inlays. Marginal fit of Endocrown was better than that of the conventional crowns, thus better chance of success when crowning endodontically treated teeth. The Endocrown was superior to conventional crown regarding vertical marginal gap and the Endocrowns with butt joint margin resulted in less marginal leakage than that with shoulder finish line.

Conclusion: the fracture resistance of the Endocrown restoration was comparable to the fiber post, core and conventional crown restoration. The Endocrown showed better marginal fit and less marginal leakage than fiber post, core and conventional crown especially with butt-joint margin. Therefore, the Endocrowns can be considered as an alternative to the fiber post, core and conventional crown in posterior endodontically treated teeth especially when there is enough tooth structure supragingival to provide this kind of adhesive restoration. More studies were needed to prove the superiority of the Endocrown over the conventional crown.

KEYWORDS
Endocrowns, Fracture resistance, Endodontically treated teeth.

INTRODUCTION

Endodontically treated teeth (ETT) are more prone to fracture. One of the key reasons for this increased weakness is the lack of tooth substance following the pathological process and endodontic treatment of the tooth in question. This biomechanical alteration inflicts a negative impact on the long-term prognosis of the tooth. Therefore, when considering the restoration of devitalized teeth, dental materials should be able to replace the loss of tooth substance in order to ensure mechanical and functional properties, esthetics and coronal seal.1-4

Endodontic procedures have been shown to reduce tooth stiffness by only 5% whereas an MOD preparation reduces tooth stiffness by 60%.5,6 In a large clinical study the fracture rate for uncrowned molars was double that restored with crowns. The success rate for maxillary molars dropped from 97.8% for those with crowns to 50% for those without crown.5,7
The tooth structure remaining after endodontic therapy also exhibits irreversibly altered physical characteristics. Changes in collagen cross linking and dehydration of the dentin result in a 14% reduction in strength and toughness. Maxillary teeth are stronger than mandibular teeth and mandibular incisors are the weakest. The internal moisture loss is approximately 9% and is greater in anterior than posterior ones. This combined loss of structural integrity, loss of moisture and loss of dentin toughness compromises endodontically treated teeth. Restoration of endodontically treated teeth with extensive coronal loss has always followed a strict protocol, with the fabrication of total crowns supported on metal cores and/or glass fiber posts. Initially, it was believed that this procedure would provide better reinforcement of the remaining dental structure. However, it has been observed that the use of intracanal retainers only promoted retention of the prosthetic crown. As a result of removing a healthy dental structure to enable the placement of rigid elements devoid of mechanical behaviors similar to those of the tooth the remaining tooth could be weakened.

With the advent of adhesive dentistry moreover, the appearance of ceramics that had high mechanical strength and were capable of being acid etched (such as those reinforced with leucite or lithium disilicate), allied with the adhesive capacity of adhesive systems and resinous cements, made it possible to restore posterior teeth, especially molars, without cores and intraradicular posts, became feasible to restore posterior teeth with extensive coronal destruction without the use of radicular posts and while using the entire extension of the pulp chamber as a retentive resource.

The Endocrown is a total porcelain crown fixed to a devitalized tooth, which is anchored to the internal portion of pulp chamber and cavity margins, thus obtaining macromechanical retention (provided by the pulpal walls) and microretention (by using adhesive cementation). It allow performing a more conservative, faster and less expensive dental treatment. With the advent of adhesive dentistry, it has become acceptable to restore teeth with extensive coronal destruction by performing endocrowns without using posts and by using extension of the pulp chamber as a retentive resource. The first study published on Endocrown was conducted by Pissis in 1995. He described the ceramic monoblock technique for teeth with extensive loss of coronal structure. In 1999 Bindl and Mormann who named this restorative procedure "endocrown". 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 on the ceramic covering on the metal or ceramic substructures. This technique has many advantages such as it easily performed demands less clinical time when compared with conventional crowns, costs less because of the fewer number of steps involved, overcomes the patient’s lack of available time, and has good esthetic acceptance because it is made of ceramic. Its maintains the biomechanical integrity of the tooth, the pulp chamber add retention of the restoration. Allow re-entry to the canals if required without post removal, avoid intra-radicular preparation and further compromise of the root structure.

**MATERIAL AND METHODS**

The collected data were systematically reviewed the previous randomized control trails that compared the Endocrown with fiber post, core and conventional crown as endodontically posterior teeth restorations from 2008-2018 according to the following inclusion criteria:

1. Endodontic treated posterior teeth.
2. Endocrown compared with fiber post, core and conventional crown.
3. Comparing the fracture resistance of both restorations.
4. Comparing the marginal fitness of both restorations.

After the data collection fifteen paper critically reviewed and only eight matched our inclusion criteria. Six of these randomized control trails compared the fracture resistance of the compared restorations and only two compared the marginal fitness.
RESULTS

Fracture Resistance:
According to (Chia-Yu Chang et al. 2009) the bonded ceramic endocrowns showed a significantly higher fracture resistance than the classic reinforced and designed group and, therefore, offer a feasible alternative for severely damaged teeth in their study they evaluated twenty extracted premolars endodontically treated, tent teeth restored with fiber post and composite core, ceramic crown and others restored with ceramic Endocrowns. Endocrown restorations presented greater fracture strength than indirect conventional crowns associated with glass fiber posts and resin composite filling cores. For both groups, the failure pattern was characterized by fracture of the tooth associated with displacement of the restoration on the opposite side according to (GR Biacchi et al. in 2011).

Endocrowns can be considered as a feasible conservative and esthetic alternative to post and core supported full crowns for the restoration of endodontically treated posterior teeth. Regarding the high stiffness materials like zirconia negatively modify the biomechanical behavior of the endocrown restorative system. The low stiffness materials such as resin composites accompany the natural flexural movements of the tooth, reducing stress arising at the interfaces. Thus, restorative materials with mechanical properties as similar as possible to those of natural tooth hard tissues, enable the restored system to mimic the mechanical behavior of a natural tooth producing a monoblock. From a clinical point of view, resin composites seem to be the most reliable materials to build-up endocrown restorations that restore the structural integrity and the strength of endodontically treated and severely damaged teeth (Shereen El Sayed et al. 2013).

In 2015 Abdel-Aziz M. et al. were found in their study the presence of ferrule increased the fracture resistance of endodontically treated premolars restored with either Endocrown or glass fiber post and core and all-ceramic crown than those without ferrule. In same year (Hamdy A et al.) concluded the full coverage, intact teeth and endocrowns showed the highest fracture resistance respectively with no significant difference. Onlays then inlays showed the least fracture resistance resistance. Full coverage group showed the best mode of failure and inlay showed the worst. However the restoration of mandibular premolar, Endocrown shows no advantage in fracture resistance when compared with the fiber post retained restorations, but the two methods cannot rehabilitate endodontically treated teeth with the same fracture resistances that intact mandibular premolars have, according to (Jing Guo et al. in 2016).

Restorations Margin Fitness:
In 2015, Abo-Elmagd A. et al. found the Endocrown was superior to conventional crowns with fiber post and composite core regarding vertical marginal gap. Endocrown with butt joint margin resulted in less marginal leakage than that with shoulder finish line. However, the margin design had no significant effect on vertical marginal gap, the marginal fit of Endocrown was better than that of the conventional crown where mean marginal fit values of Endocrowns were significantly less than that in conventional crowns. Thus better chance of success when crowning endodontially treated teeth. (Dalloul R. et all. 2016).

DISCUSSION

Fracture Resistance:
In 2009, Chia-Yu Chang et al. compared the fracture resistance and failure modes of CEREC endo-crowns with the CEREC classic designed crown supported with glass fiber-reinforced composite posts and composite cores, they found the mean fracture resistance ± standard deviation was recorded as follows: 1163.30±163.15 N for group C and 1446.68±200.34 N for group E. A significant difference was found between groups with respect to fracture resistance (P<0.05). Regarding failure modes, most specimens of both groups exhibited unfavorable fractures, and no significant difference was found between the two groups. Also Biacchi GR. et al. in 2011 were compared the fracture strength of full ceramic crowns using two techniques-indirect conventional crowns retained by glass fiber posts, and endocrowns with an “anchorage” in the pulp chamber-and analyze the failure mode and their results were showed significant differences between
For the restoration of mandibular premolar, endo-
crown shows no advantage in fracture resistance
when compared with the conventional method.
Regarding the construction concept, endocrowns
can be considered as a feasible conservative and
esthetic alternative to post and core supported
full crowns for the restoration of endodontically
treated posterior teeth. Regarding the construct-
ing material, high stiffness materials like zirconia
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try, low stiffness materials such as resin compos-
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view, resin composites seem to be the most
reliable materials to build-up endocrown restora-
tions that restore the structural integrity and the
strength of endodontically treated and severely
damaged teeth.

Moreover, clear differences were found in the
failure patterns between the conventional and
endocrown systems. The failure pattern was charac-
terized by fracture of the tooth associated with
displacement of the restoration, whereas with the
endocrown, failure was localized to the restora-
tion. This highlights the advantages of endocrowns
in terms of preserving the natural anatomy of the
tooth, reducing stress arising at the interfaces.

In conclusion, endocrowns represent a viable
alternative for the restoration of endodontically
treated premolars, offering improved clinical
outcomes compared to conventional methods.

### Table 1

<table>
<thead>
<tr>
<th>Title</th>
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<tr>
<td>Fracture Resistance of Translucent Zirconia and Resin Nano Ceramic Endocrowns versus Fiber Post and Core supported Crowns using CAD/CAM Technology</td>
<td>Shereen El Sayed</td>
<td>2013</td>
<td>Group I exhibited the highest fracture resistance, followed by group IV, then group III, while group II exhibited the lowest fracture resistance values. Groups I and II resulted in unfavorable unrestorable failures while Groups III and IV resulted in favorable restorable failures.</td>
<td>Regarding the construction concept, endocrowns can be considered as a feasible conservative and esthetic alternative to post and core supported full crowns for the restoration of endodontically treated posterior teeth. Regarding the constructing material, high stiffness materials like zirconia negatively modify the biomechanical behavior of the endocrown restorative system. On the contrary, low stiffness materials such as resin composites accompany the natural flexural movements of the tooth, reducing stress arising at the interfaces. Thus, restorative materials with mechanical properties as similar as possible to those of natural tooth hard tissues, enable the restored system to mimic the mechanical behavior of a natural tooth producing a monoblock. From a clinical point of view, resin composites seem to be the most reliable materials to build-up endocrown restorations that restore the structural integrity and the strength of endodontically treated and severely damaged teeth.</td>
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<td>Comparison of Fracture Strength of Endocrowns and Glass Fiber Post Retained Conventional Crowns</td>
<td>GR Biacchi</td>
<td>2011</td>
<td>Results showed significant differences between the two groups (p=0.002), with Group GE shown to be more resistant to compressive forces than Group GC.</td>
<td>Endocrown restorations presented greater fracture strength than indirect conventional crowns associated with glass fiber posts and resin composite filling cores. For both groups, the failure pattern was characterized by fracture of the tooth associated with displacement of the restoration on the opposite side.</td>
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<td>Effect of Full Coverage, Endo-crowns, Onlays, Inlays Restorations on Fracture Resistance of Endodontically Treated Molars</td>
<td>Ahmed Hamdy</td>
<td>2015</td>
<td>Mean failure loads were group 1: 1,985 N, group 2: 1,076 N, group 3: 989 N, group 4: 908 N and group 5: 638 N respectively. As regard mode of failure: group 1: 40% restorable, group 2: 90% restorable, group 3: 80% restorable, group 4: 80% restorable and group 5: 30% restorable.</td>
<td>1-Full coverage, intact teeth and endocrowns showed the highest fracture resistance respectively with no significant difference. 2-Onlays then inlays showed the least fracture resistance resistance. 3-Full coverage group showed the best mode of failure and inlay showed the worst.</td>
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<td>Effect of endo-crowns and glass fiber post-retained crowns on the fracture resistance of endodontically treated premolars</td>
<td>Mohamed Abdel-Aziz</td>
<td>2015</td>
<td>One way ANOVA test showed that group (4) recorded statistically significant (p &lt;0.05) highest mean value (1262.71±277.8 N) followed by group (2) (1139.7±227.94 N) then group (1) (725.73±137.89 N). Group (3) recorded the lowest statistically significant (p &lt;0.05) mean value (588.17±94.11 N). Pair-wise Tukey’s post-hoc test showed non-significant (P&gt;0.05) difference between 2 and 4 groups.</td>
<td>Within the limitations of this study, the presence of ferrule increased the fracture resistance of endodontically treated premolars restored with either endocrown or glass fiber post-and core and all-ceramic crown than those without ferrule.</td>
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<td>Fracture resistance and failure modes of CEREC endo-crowns and conventional post and core-supported CEREC crowns</td>
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| A comparison of the fracture resistances of endodontically treated mandibular premolars restored with endocrowns and glass fiber postcore retained conventional crowns | Jing Guo | 2016 | The fracture resistances of GE and GC were significantly lower than that of GI (P<0.01), while no significant difference was found between GE and GC (P=.702). As of the failure modes, most of the specimens in GE and GC were unfavorable while a higher occurrence of favorable failure mode was presented in GI. | For the restoration of mandibular premolar, endo-
crown shows no advantage in fracture resistance when compared with the conventional method. Both of the two methods cannot rehabilitate endodontically treated teeth with the same fracture resistances that intact mandibular premolars have
the two groups (p = 0.002), with Group GE (restored with endocrown) shown to be more resistant to compressive forces than Group GC (restored with conventional crown, filling core and glass fiber posts).10

The fracture resistance and fracture modes of Zirconia and Resin Nano Ceramic Lava Ultimate CAD/CAM Endocrowns and post and core supported CAD/CAM classical crowns in extensively damaged endodontically treated maxillary molars, were examined by (El Sayed S. in 2013)26 and they reached to the group treated teeth restored by fiber posts composite core and zirconia exhibited the highest fracture resistance, followed by group treated by Lava Ultimate (LU) Endocrowns, then the teeth restored with Endocrown without ferrule (725.73±137.89N). However, the lowest statistically significant (p < 0.05) mean value (588.17±94.11N) recorded in the teeth restored with Glass fiber post and resin core and conventional crown without ferrule. These results showed the ferrule presence significantly increased the fracture resistance of endodontically treated teeth restored with both Endocrown and fiber post and core and full ceramic crown. However the fracture resistances of GE (endocrown group) and GC (post-core supported crown group) were not different significantly (P = .702), but both restorations significantly lower than that of GI (intact teeth group) (P < .01) according to (Jing Guo et al. in 2016).28

Influence of marginal preparation design on microleakage and marginal gap of endocrowncemented with adhesive resin cement

Abo-Elmagd A. 2015

Gr 1 (Fiber post and conventional crown) recorded statistically significant (p <0.05) highest vertical marginal gap mean value (73.02 ± 24.94μm), followed by Gr3 (endocrown with shoulder FL) (46.72±13.1 μm), then, Gr 2 (endocrown with butt margin) (44.66±10.71μm) as indicated by one-way ANOVA test. Pair-wise Tukey’s post-hoc test showed non-significant difference in the vertical marginal gap mean value (P>0.05) between endocrown groups; (2) and (3). For microleakage, Gr 3 (endocrown with shoulder FL) recorded statistically significant (p<0.05) highest marginal leakage mean value (109.76±4.4μm), followed by Gr 1 (Fiber post and conventional crown) (84.17 ± 1.9 μm). While Gr 2 (endocrown with butt margin) recorded the lowest statistically significant (p <0.05) mean value (55.46±4.1 μm) as indicated by one way ANOVA test. Pair-wise Tukey’s post-hoc test showed significant difference (p <0.05) between all groups.

A Comparative Study of Marginal Fit between IPS e.max Press Crown and Endocrown after Cementation (In Vitro)

Dalloul R. 2016

The mean marginal fit in group E (34.38μm±3.23) was that in group C (47.08 μm ±SD4.96) P=0.000. The mean marginal fit of proximal surfaces in group E (Mesial 22.08 μm±4.43 and Distal 21.54 μm ±3.16), was significantly less than that of Buccal and Lingual surfaces (46.15 μm±8.18, 47.77 μm±9.87) respectively P=0.000.

Marginal fit of Endocrown was better than that of the conventional crown. Thus better chance of success when crowning endodontically treated teeth. However, clinical studies are needed to confirm this finding.

Marginal fit of Endocrown was superior to conventional crown regarding vertical marginal gap. 2) Endocrown margin design had no significant effect on vertical marginal gap. 3) Endocrown with butt joint margin resulted in less marginal leakage than that with shoulder finish line.

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Restorations Margin Fitness: Abo-Elmagd A. 2015 evaluated the microleakage and vertical marginal gap of lithium disilicate ceramic Endocrown with either butt margin or shoulder finish line by in vitro study and they found the fiber post and conventional crown group recorded statistically significant (p<0.05) highest vertical marginal gap mean value (73.02 ± 24.94 μm), followed by Endocrown with shoulder finish line (46.72 ± 13.1 μm), then, Endocrown with butt margin group (44.66 ± 10.71 μm) as indicated by one way ANOVA test. While Pair-wise Tukey’s post-hoc test showed non-significant difference in the vertical marginal gap mean value (P=0.05) between Endocrown groups; For microleakage, Endocrown with shoulder finish line group recorded statistically significant (p<0.05) highest marginal leakage mean value (109.76 ± 4.4 μm), followed by Fiber post and conventional crown group (84.17 ± 1.9 μm). While Endocrown with butt margin group recorded the lowest statistically significant (p<0.05) mean value (55.46 ± 4.1 μm) as indicated by one way ANOVA test, but Pair-wise Tukey’s post-hoc test showed significant difference (p<0.05) between all groups.19 according to (Rana Dalloul et al. in 2016) in their in vitro study were evaluated the marginal fit of two types of IPS E.max Press crowns after cementation (conventional crown and Endocrown). They found significance was predetermined at p<0.05. The mean marginal fit of Endocrowns (34.38 ± 3.3) was that in group conventional crown (47.08 ± SD4.96) P=0.000. The mean marginal fit of proximal surfaces in Endocrown group (Mesial 22.08 ± 4.43 and Distal 21.54 ± 3.16) was significantly less than that of Buccal and Lingual surfaces (46.15 ± 8.18, 47.77 ± 9.87) respectively (P=0.000) that making the marginal fitness of Endocrown was better than that of the conventional crown.

CONCLUSION

With the limitation of this study, the fracture resistance of the Endocrown restoration was comparable to the fiber post, core and conventional crown restoration. The Endocrown showed better marginal fit and less marginal leakage than fiber post, core and conventional crown especially with butt-joint margin. Therefore, the Endocrowns can be considered as an alternative to the fiber post, core and conventional crown in posterior endodontically treated teeth especially when there is enough tooth structure to provide this kind of adhesive restoration. However more studies were needed to prove the superiority of Endocrown over the conventional crown in posterior teeth.

REFERENCES