Marginal and Internal Adaptation of Zirconia Endocrowns - A Literature Review

Mehrnaz Karimi Afshar¹, Hossein Ali Mahgoli², Saied Nokar³, Mehran Bahrami⁴

¹Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. ²Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. ³Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran. ⁴Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran, Iran.

ABSTRACT

BACKGROUND
One of the important factors in the success of teeth with endocrown restorations is to achieve minimum values of internal and marginal gap. The purpose of this review article is to explore the information published in the marginal and internal adaptations of zirconia endocrowns.

METHODS
This review article was conducted using keywords of CAD/CAM, Endocrown and Marginal and internal adaptation in the Medline database. The search range included all relevant articles by the end of 2018.

RESULTS
The results of this study showed that 12 studies by the end of 2018 examined marginal and internal adaptation of endocrowns. Most studies were conducted in laboratory conditions. A majority of studies, which compared CAD/CAM systems, showed that the compared groups in terms of marginal and internal adaptation of endocrowns were in the clinically acceptable range in most cases.

CONCLUSIONS
A review of included studies showed that the endocrowns have the same or better marginal and internal adaptation compared to conventional crowns. However, there is a need for further studies with larger sample size and clinical trials in this area.

KEY WORDS
Endocrown, Marginal Adaptation, Internal Adaptation, CAD/CAM

Corresponding Author:
Mehran Bahrami,
Department of Prosthodontics,
School of Dentistry,
Tehran University of Medical Sciences,
North Karegar Street, Tehran, Iran.
E-mail: m.bahrami.sina@gmail.com
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Endocrown is an integrated restoration that is made due to advances in adhesion techniques for teeth with history of endodontic treatment. This restoration consists of a crown portion and a cavity portion inside the pulp chamber, where the surface of the pulp chamber is used to stabilize and fix the restoration through a cement adhesive instead of the post-core system. The manufacture of endocrowns has been facilitated in recent years due to advances in CAD/CAM (computer-aided design and computer-aided manufacturing) technology. Endocrowns, as a suitable substitute for the crown, are useful when reconstructing posterior endodontic teeth, especially in teeth with a minimum crown height that has sufficient tissue for stable cement.

The benefits of endocrowns include no need to increase crown length, no need for technical steps such as post cement construction and no need for core construction and temporary restoration. The clinical success rate of these treatments has also been reported to be in the range of 94%-100%, which is high statics.

Achieving minimum values of internal and marginal discrepancy is one of the basic parameters in dental restoration. Marginal gap causes dental plaque accumulation, cement dissolution, periodontitis or decay, and ultimately fracture of restoration. The acceptable clinical limit is 120 μm for the marginal gap in the restorations. Primary CAD/CAM restoration had a poor adaptation with a gap of more than 270 μm. The range of marginal gap values for CAD/CAM restoration has been reported differently before the cementation, ranging from 85 to 247 μm. In this regard, and with the advancement of technology, CAD/CAM has improved the amount of marginal adaptation of restoration significantly.

During the process of making restoration with CAD/CAM, manufacturing accuracy is affected by various factors, such as scanning, geometric data processing, calculating milling parameters, actual milling process, and ceramic shrinkage during the sintering process. Due to the variability of these parameters in various CAD/CAM systems, the role of the system must be considered about the dimensional changes and the accuracy of marginal restoration.

Regarding the internal and marginal gap of endocrowns, one of the important factors in the failure of treatment, this study examined the information published on marginal and internal adaptation of zirconia endocrowns.

This review article was conducted using keywords of CAD/CAM, Endocrown and Marginal and internal adaptation in the Medline database. The search range included all relevant articles by the end of 2018. Totally, 66 articles were found in this field. Only clinical and laboratory trials on endocrowns were enrolled in analysis; case reports, case series, pilot studies, review articles, and laboratory studies aimed at evaluating the characteristics of endocrowns, excluding marginal and internal adaptation, were excluded from the study. Finally, 12 articles on marginal and internal adaptation of endocrowns were investigated.

Of the articles reviewed, 12 articles related to marginal and internal adaptation of zirconia endocrowns were reviewed. The demographic characteristics of the articles studied are presented in Table 1. These articles compared CAD/CAM systems or different depths of milling cavity and its effect on marginal and internal adaptation of endocrowns. Table 2 shows the compared groups and the corresponding outcomes.

**Table 1. Demographic Characteristics of Studies**

<table>
<thead>
<tr>
<th>Country</th>
<th>Type of Study</th>
<th>Year</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>Retrospective Clinical trial</td>
<td>1999</td>
<td>Bindi</td>
</tr>
<tr>
<td>Spain</td>
<td>In vitro</td>
<td>2013</td>
<td>Ramirez-Sebastia</td>
</tr>
<tr>
<td>Egypt</td>
<td>In vitro</td>
<td>2015</td>
<td>Abo Elmagd</td>
</tr>
<tr>
<td>India</td>
<td>In vitro</td>
<td>2015</td>
<td>Rajan</td>
</tr>
<tr>
<td>Switzerland</td>
<td>In vitro</td>
<td>2016</td>
<td>Rocca</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>In vitro</td>
<td>2016</td>
<td>Gaikaritopoulos</td>
</tr>
<tr>
<td>Egypt</td>
<td>In vitro</td>
<td>2016</td>
<td>El Guindy</td>
</tr>
<tr>
<td>Syria</td>
<td>In vitro</td>
<td>2016</td>
<td>Bailout</td>
</tr>
<tr>
<td>Korea</td>
<td>In vitro</td>
<td>2017</td>
<td>Shin</td>
</tr>
<tr>
<td>Egypt</td>
<td>In vitro</td>
<td>2017</td>
<td>Darwish Ahmed</td>
</tr>
<tr>
<td>Germany</td>
<td>In vitro</td>
<td>2018</td>
<td>Tabi</td>
</tr>
<tr>
<td>Switzerland</td>
<td>In vitro</td>
<td>2018</td>
<td>Rocca</td>
</tr>
</tbody>
</table>

**Table 2. Comparison of Results**

<table>
<thead>
<tr>
<th>Country</th>
<th>Type of Tooth</th>
<th>Comparison</th>
<th>Group</th>
<th>Year</th>
<th>Author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Switzerland</td>
<td>Molar</td>
<td>CEREC</td>
<td>1</td>
<td>2012</td>
<td>Bindi</td>
</tr>
<tr>
<td>Endo crown</td>
<td>Premolar</td>
<td>E4D</td>
<td>48(6)</td>
<td>2017</td>
<td>Ramirez-Sebastia</td>
</tr>
<tr>
<td>Mesial margin</td>
<td>Molar</td>
<td>29-32</td>
<td>2017</td>
<td></td>
<td>Rajan</td>
</tr>
<tr>
<td>In all groups</td>
<td>Molar</td>
<td>E4D</td>
<td>48(6)</td>
<td>2017</td>
<td>Rocca</td>
</tr>
<tr>
<td>Significant gap</td>
<td>Molar</td>
<td>E4D</td>
<td>48(6)</td>
<td>2017</td>
<td>Rocca</td>
</tr>
<tr>
<td>Vertical gap</td>
<td>Molar</td>
<td>1-Lava</td>
<td>8</td>
<td>2014</td>
<td>El Guindy</td>
</tr>
<tr>
<td>Result</td>
<td>Molar</td>
<td>E4D</td>
<td>48(6)</td>
<td>2017</td>
<td>Saleh</td>
</tr>
</tbody>
</table>

**METHODS**

This review article was conducted using keywords of CAD/CAM, Endocrown and Marginal and internal adaptation in the Medline database. The search range included all relevant articles by the end of 2018. Totally, 66 articles were found in this field. Only clinical and laboratory trials on endocrowns were enrolled in analysis; case reports, case series, pilot studies, review articles, and laboratory studies aimed at evaluating the characteristics of endocrowns, excluding marginal and internal adaptation, were excluded from the study. Finally, 12 articles on marginal and internal adaptation of endocrowns were investigated.
and E4D showed similar gap values in endocrowns. Therefore, the values of the internal and marginal gap in the endocrowns in terms of increasing the cavity depth and the cementation process had no effect on increasing the dimensions of the gap between the restoration and the cavity wall. On the other hand, the gap value in the pulp chamber floor appeared to have had an impact on these results.  

Gaintantzopolou et al. assessed the effect of preparation and intracanal dressing on the marginal and internal adaptation of CAD/CAM endocrowns. In this study, Vita Enamic endocrowns were evaluated in three groups, including 2-mm intracoronal milling depth without intracanal dressing, 1- and 2-mm intracanal dressings. The results showed that lack of intracanal dressing showed the least gap value.  

Ahmed Darwish et al. also examined the internal adaptation of lithium disilicate and resin nanoceramic endocrowns with different preparation designs. This study evaluated the effect of axial wall convergence (6 and 10°) and the prepared depth (3 and 5 mm) of IPS Emax CAD and Lava Ultimate endocrowns. All restoration was made by CEREC CAD/CAM system. The results of this study showed that resin nanoceramic endocrowns regardless of milling design had a better internal adaptation compared to lithium disilicate endocrowns.  

Abo Elmagd et al. (2015) investigated the effect of marginal milling design on the microleakage and the marginal gap of endocrowns cemented with resin cements. This study evaluated the vertical marginal gap and the microleakage of lithium disilicate endocrowns with butt margin and shoulder finish line with 1-mm width and 2-mm axial wall height. The results showed that the marginal milling design had no significant effect on the vertical marginal gap. The endocrowns with butt margin showed less microleakage than the shoulder margin.

A review of studies showed that only one study used maxillary anterior teeth for comparison. In this study, Ramirez-Sebastia et al. measured the effect of post length on marginal adaptation. The results showed that the post length had no significant effect on marginal adaptation. However, the rest of the studies were done on the posterior teeth. Due to different forces on posterior and anterior teeth, there is a need for further studies on anterior teeth.

**Table 2. The Compared Groups and the Corresponding Main Outcomes**

<table>
<thead>
<tr>
<th>Group</th>
<th>Material</th>
<th>Marginal Gap</th>
<th>Internal Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>Lithium disilicate</td>
<td>0.01 mm</td>
<td>0.02 mm</td>
</tr>
<tr>
<td>Group 2</td>
<td>Titanium dioxide</td>
<td>0.02 mm</td>
<td>0.03 mm</td>
</tr>
<tr>
<td>Group 3</td>
<td>Zirconia</td>
<td>0.03 mm</td>
<td>0.04 mm</td>
</tr>
</tbody>
</table>

**DISCUSSION**

Most of these studies have compared CAD/CAM systems or different milling depths. Only four studies have pointed to the comparison of conventional crown with endocrowns. Among these four studies, Daulet et al. reported that the endocrown had a better marginal adaptation than conventional crowns, while Rocca et al. found no significant difference in the margin integrity between endocrown and classic crown groups. As well, Ramirez-Sebastia showed that there is no difference between endocrowns and crowns in the marginal adaptation after loading.

Most studies were related to recent years (2013 onwards) and within vitro design. Only one study in 1999 was a clinical trial, which determined the survival rate and clinical quality of ECEC endocrowns after two years. According to the results, endocrown 19 function time was 14-35.5 months and the molar endocrown 1 was eliminated after 28 months due to decay recurrence. Overall, the clinical quality of CEREC endocrowns was very well reported, and this clinical approach also seemed to be applied.  

In most studies, the rate of marginal adaptation in all groups after loading was significantly lower than before. However, there was no significant difference after loading between the groups compared in some of these studies, including those by Taha and Rucca. However, some studies indicate a significant difference between the groups. For example, Darwish Ahmad found that resin nanoceramic endocrowns exhibited a better internal adaptation than lithium disilicate. EL Guindy suggested that the mean vertical marginal gap in the Emax CAD group was significantly higher than the LAVA Ultimate group. Rajan showed that the marginal adaptation of the CEREC-In Lab MC XL system was greater than the CERAMILL system.

Among studies, Shin et al. reported the values of internal and marginal gap of endocrowns with different depth values through micro-CT tomography calculations. According to the results, endocrowns with 4-mm cavity showed larger internal and marginal discrepancies than endocrowns with 2-mm cavity. The cementation process did not produce significant differences in terms of total gap thickness. In addition, the gap values in the pulp chamber floor were estimated to be higher than other areas. Both CAD/CAM systems (CEREC AC

**CONCLUSIONS**

A review of included studies showed that the endocrowns have the same or better marginal and internal adaptation compared to conventional crowns. However, the results should be interpreted with caution due to the laboratory design of most studies and there is a need for further studies with larger sample size and clinical trials in this area.

**REFERENCES**


