Marginal and Internal Adaptation of Zirconia Endocrowns - A Literature Review

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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

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BACKGROUND

Endocrown is an integrated restoration that is made due to advances in adhesion techniques for teeth with history of endodontic treatment.[1] 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.[2]

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.[3] The clinical success rate of these treatments has also been reported to be in the range of 94%-100%, which is high statics.[4]

Achieving minimum values of internal and marginal discrepancy is one of the basic parameters in dental restoration.[5] Marginal gap causes dental plaque accumulation,[6] cement dissolution, periodontitis[7] or decay,[8] and ultimately fracture of restoration. The acceptable clinical limit is 120 µm for the marginal gap in the restorations.[9] Primary CAD/CAM restoration had a poor adaptation with a gap of more than 270 µm.[10] The range of marginal gap values for CAD/CAM restoration has been reported differently before the cementation, ranging from 85 to 247 µm.[11] In this regard, and with the advancement of technology, CAD/CAM has improved the amount of marginal adaptation of restoration significantly.[12]

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.[13] 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.[12]

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.

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.

RESULTS

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.

Country	Type of Study	Year	Author
Swiss	Retrospective Clinical trial	1999	Bindl
Spain	In vitro	2013	Ramirez-Sebastia
Egypt	In vitro	2015	Abo Elmagd
India	In vitro	2015	Rajan
Swiss	In vitro	2016	Rocca
United Arab Emirates	In vitro	2016	Gaintantzopolou
Egypt	In vitro	2016	El Guindy
Syria	In vitro	2016	Dallout
Korea	In vitro	2017	Shin
Egypt	In vitro	2017	Darwish Ahmed
Germany	In vitro	2018	Taha
Swiss	In vitro	2018	Rucca

Table 1. Demographic Characteristics of Studies

Results	Type of Tooth	Comparison Groups	No. (In Group)	Author/s
After 2 years clinical quality (adaptation) CEREC endocrown were very good	Molar and premolar	CEREC	19	Bindl[1]
Endo cpr, Spcer, LPcpr Showed the most marginal integration. Effect of post length on marginal adaptation was not significant.	incisor	1-Lpcer Lp= long post, 2-Spcer Sp= short post, 3-LPcpr cer= ceramic CAD/CAM, 4-Spcpr cpr= composite CAD/CAM, 5-Endo cer Endo = endocrown, 6-Endo cpr	48 (8)	Ramirez-Sebastia[14]
Marginal design had no significant effect on vertical marginal gap. endocrown with butt margin showed lesser micro leakage than shoulder margin.	premolar	1- Fiber post conventional crown, 2- Endocrown with butt margin, 3- Endocrown with shoulder finish line	15 (5)	Abo Elmagd[15]
Marginal adaptation in CEREC-In Lab MC XL was better than CERAMILL. both system coping had acceptable internal adaptation and marginal adaptation	molar	1- CERAMILL 2-CEREC-In Lab MC XL	20 (10)	Rajan[16]
In all groups complete marginal adaptation after loading were significantly lesser than before loading. There were no significant differences between marginal adaptation before and after loading in experimental groups.	molar	1-Hybrid resin composite(GC), 2- 1 covered by 3 Meshes of E glass fibres, 3-FRC resin, 4-3 covered by 3 Meshes of E glass fibres	32 (8)	Rocca[3]
Significant differences between marginal and internal marginal gap in 3 groups were seen. No expansion in root showed lesser gap.	resin endodontic tooth models	1-Endocrown with intracoronal preparation depth of 2 mm, 2-Endocrown with extra 1 mm extension in the root canal intraradicular, 3- Endocrown with extra 2 mm extension in the root canal intraradicular		Giant-Antzopolou[17]
Vertical marginal gap was significantly more in E. Max CAD. vertical marginal gap in both groups were in Clinical acceptable range.	molar	1- LAVA Ultimate 2-E. Max CAD	8 (4)	El Guindy[18]
Results show endocrown had better marginal adaptation than conventional crowns(47).	molar		20 (16)	Dallout[19]
endocrown with a 4-mm cavity showed a larger marginal and internal volume than one with a 2-mm cavity.	molar	1-CEREC AC with 2 mm cavity depth, 2-CEREC AC with 4 mm cavity depth, 3-E4D with 2 mm cavity depth, 4-E4D with 4 mm	48 (12)	Shin[20]

Both CAD/CAM systems similar discrepancy in the endocrowns		cavity depth		
Resin nano ceramic endocrown showed better internal adaptation than lithium disilicate	premolar	1- LS10 L=Lava, 2-LS6b E=IPS e. max, 3-LD10 S=shallow depth(3 mm), 4-LD6 D=extended depth(5 mm), 5-ES10 6, 10-degree axial wall, 6-ES6 divergence, 7-ED10, 8- ES6	40 (5)	Darwish Ahmed[21]
All groups showed acceptable range in marginal adaptation, but significant differences were seen in gap after cementation and thermomechanical aging	molar	1- Lithium disilicate ceramics (LSC), 2-Polymer infiltrated ceramics, 3-Zirconia reinforced LSC, 4- Resin nanoceramics	40 (10)	Taha[22]
There were no significant differences between group 2 and 3 with classic crown, but there were significant differences between groups before and after loading.	premolar	1- no endocore (negative control), 2-endocrown with end- core of 2 mm 3- endocrown with end- core of 4 mm, 4- crowns with post and core (positive control)	48 (12)	Rucca[23]

Table 2. The Compared Groups and the Corresponding Main Outcomes

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, Daullet et al.[19] and Abo Elmgad et al.[15] 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.[23] As well, Ramirez-Sebastia[14] 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.[1]

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.[3,22, and 23] However, some studies indicate a significant difference between the groups. For example, Darwish Ahmad[21] 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.[18] Rajan[16] 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 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.[20]

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.[17] 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.[21] 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[14] 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.

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.

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