Review Article

A Comparative Study of Marginal Adaptation between Monolithic and Layered Zirconia Crowns: A Literature Review

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Abstract

Introduction: Marginal adaptation highly affects the long-term success of crowns. This study intends to investigate the marginal adaptation of monolithic zirconia and veneered zirconia crowns. **Methods:** Based on our searches in PubMed and Google Scholar from 2011 to 2020, 22 articles were obtained, and after studying their full-texts. Five articles that were most related to our subject were selected. **Results:** In almost all articles, the greatest mean marginal gap value was recorded for monolithic zirconia, whereas layered zirconia crowns demonstrated the lowest mean marginal gap values. **Conclusion:** Based on finding of the current study, monolithic zirconia restorations had a superior marginal adaptation than layered zirconia restorations. However, clinically both restorations have an acceptable marginal fit

Keywords: Monolithic zirconia restoration, Layered zirconia restoration, Marginal adaptation, Dental ceramic.

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Introduction

Capturing an accurate impression is one of the critical steps in fabricating fixed dental restorations (1, 2). Precise replication should be taken to create an acceptable marginal gap (3,4). Any sort of compromise in the adaptation between the tooth and restoration, may result in a marginal gap. This gap is an area for accumulation of causative bacteria in periodontal disease. Therefore, inadequate marginal adaptation can jeopardize the health of periodontal tissues (5,6). Poor adaptation of the crown can lead to dissolution of most type of cements which poses a greater risk for subsequent complications such as tooth sensitivity, a higher incidence of recurrent caries and inflammation of periodontal tissues (7). In addition, variations in adaptation could lead to stress concentration which compromises the fracture resistance of these restorations and consequently result in fracture and failure (8, 9). Reviewing the results of previous studies show that the marginal adaptation of zirconia-based restorations had acceptable values for clinic use (10, 11). Today, high-translucency zirconia in addition to strength provides aesthetic without requiring porcelain veneering and thus, obviating complication like porcelain chipping (12). Although some studies have indicated that monolithic zirconia restorations have better mechanical and esthetic properties, few articles are available to evaluate the marginal fit of monolithic versus layered zirconia restorations (13,14).

The current review aims to summarize research articles conducted on the marginal adaptation of monolithic zirconia versus veneered zirconia crowns and to compare them to attain information about the marginal accuracy of these restorations.

Materials and Methods

This review started with a PubMed and Google Scholar search from 2011 to 2020. The investigation was conducted using the following keyword of monolithic zirconia, veneered zirconia and marginal fit. Based on our search 22 articles were obtained, and after studying their full texts, five articles relevant to our subject were selected and reviewed. The inclusion criterion was

concurrent evaluation and comparison of the marginal adaptation of monolithic and layered zirconia restorations with the same methods in each article. Techniques used to measure marginal adaptation were photography of sectioned crowns at predetermined points and then using digital or stereo microscope.

Results

Five articles discussed the marginal adaptation of monolithic and layered zirconia crowns. In a study by Rayyan MR, two groups of high-translucency monolithic zirconia and porcelain layered zirconia were included, each group consisted of ten restorations were measured at the eight measuring points with digital microscope (buccal, distal, distobuccal, distolingual, lingual, mesial, mesiobuccal and mesiolingual). Images were obtained from these points and digital microscope was used. The results of this study showed that there was no marginal gap excessive of 120µm in any of the eight measurement points. Between the two groups, a statistically significant difference in the mean value of marginal gap was observed and monolithic high-translucency zirconia restorations demonstrated superior marginal adaptation in comparison to the porcelain-layered zirconia restorations however the mean marginal gap of both groups was within the clinical goal for cemented restoration (12).

Another in-vitro study by Amuthavalli et al. a comparative evaluation of marginal restorations fabricated with zirconia cores, monolithic crowns and zirconia coping and ceramic veneering .The sample in their study were 30 dies that were divided into three groups: (Group A), ten restorations were made as zirconia copings, (Group B),ten crowns were made using zirconia coping and ceramic veneering, and ten crowns were made as monolithic crowns (Group C), that were all fabricated using computer-aided design and computer-aided manufacturing (CAD/CAM). Crowns were sectioned with a grinding machine and measured for marginal fit in the stereo microscope. The established results displayed a statistically significant difference in the marginal adaptations among the three groups and monolithic restorations showed a better marginal adaptation than the other two groups (15).

Mohammed M, et al. investigated marginal and internal fit of monolithic and veneered zirconia crowns. 40 premolars were divided into two groups according to the restoration types. Group (I) consisted of ten samples restored using monolithic zirconia crowns. Group (II) consisted of 30 samples restored using veneered zirconia frameworks. Group II was subdivided into three equal subgroups according to the veneering technique. Subgroup (IIA) veneered using a manual layering technique, subgroup (IIB) veneered using a press-on technique, and subgroup (IIC) veneered using a CAD-on technique. Each tooth was vertically sectioned buccolingually using the ISO MET 4000 Linear precision Saw (Buehler) cutting at 800 rpm speed using stainless steel, and measurements at seven points were made at X150 magnification via a personal computer, connected to the Dino-Lite digital microscope statistical analysis showed a significant difference between the groups and subgroups. The highest mean value was recorded in subgroup IIA, veneered using the manual layering technique. In contrast, the lowest mean value was recorded in subgroup IIC, veneered using the CAD-on technique. Regarding the internal gap, statistical analysis revealed a significant difference. The most significant mean value was recorded in group I (monolithic), whereas the least significant mean value was recorded in subgroup IIC, veneered using the CAD-on technique (8).

Saraswathi et al, evaluated marginal vertical discrepancies of monolithic zirconia, layered zirconia and metal- ceramic restorations, A total of 30 samples, equally divided in to three groups were used. The marginal adaptation was evaluated by measuring the gap between the edges of the restoration and the finishing margin on the die; this was accomplished under a stereo microscope. Significant differences were observed between the three groups. Their study concluded that it could be associated with dimensional stability of zirconia coping sintered at 1500 ℃ later veneered with porcelain at 930 ℃. In addition, the strength of ZrO2 copings can prevent the effect of porcelain firing shrinkage (16).

Mohaghegh et al, investigated the marginal adaptation of monolithic zirconia in different thicknesses and layered zirconia crowns. In their study, 30 crowns were divided in three groups (n= 10) with different thickness included, group A: 1-mm thick layered zirconia, group B:1-mm thick monolithic zirconia, and group C: 0.5-mm thick monolithic zirconia. The marginal gap was measured on 18 points using a digital microscope. The marginal gap in all the three groups was clinically acceptable. The marginal gap in group A was significantly different from group B ($P = 0.001$) and group C ($P = 0.004$) (17).

Discussion

Porcelain veneer failure has been proven to be the primary failure cause in posterior layered zirconia crowns (18). Furthermore, an excessive marginal gap of veneered crown has been mentioned in some studies which can be due to agents like the thermal contraction of porcelain veneer. Generally, contraction of the porcelain induces a compressive force on the framework material and affects the gap size (19, 20). The framework deformation under the tension of porcelain shrinkage

raises along the margin area. also, CTE variation between the veneering porcelain and ceramic core material can cause tension pressure during cooling from glass transition to room temperature, and the marginal adaptation could be affected (21,22).

Balkaya et al. evaluated the marginal adaptation of monolithic zirconia crowns and layered zirconia crowns manufactured using CAD/CAM, and their results showed no statistically significant difference between the marginal adaptation of monolithic and layered zirconia restorations (23). Komine et al. assessed the marginal adaptation of ZrO2 copings and restorations and exhibited that there was no significant difference before and after veneering and concluded the results derived from its high strength zirconia core (24). Assadi et al, compared the marginal adaptation of a layered zirconia and monolithic zirconia restoration with three different CAD/CAM systems. The marginal adaptation of monolithic zirconia restoration showed a superior marginal adaptation than the layered zirconia restoration (25).

Several factors can affect marginal adaptation, such as finish line shape, cement space, the taper of tooth preparation, laboratory procedures, cementation, porcelain veneering, and thermal cycles (26).

McLean and Von Fraunhofer proposed that restoration would be successful if marginal gaps and cement thicknesses of < 120µm could be achieved (27).

Jalalian et al, evaluated the effect of porcelain sintering and zirconia core thickness (0.3, 0.5 and 0.7mm) on the marginal adaptation of layered zirconia restorations. In all three group, marginal gap was less than 120µm that can be successfully used in the clinic The results showed that the 0.7-mm core thickness of the zirconia core provides better marginal adaptation among three groups before and after sintering (28).

A correct marginal fit is the main requirement for long-term success of ceramic restorations.

More recently, with improvements in dental ceramic, monolithic restorations overcome the disadvantages of veneered zirconia crown which is very practical in esthetic zone. The results of several studies exhibited the marginal discrepancy of layered ceramic restorations increment after veneering; however, less studies exhibited no significant differences in marginal adaptation of veneered ceramic restorations before and after the layering procedure (29). monolithic zirconia crowns have functional and esthetic properties such as good strength, good wear resistance but the main advantage is less tooth reduction (0.5mm) as compared to veneered zirconia and metal ceramic restoration (1.5-2mm) (30).

Considering these advantages of monolithic zirconia restoration including outstanding strength, satisfactory esthetic properties and comparable marginal adaptation with veneered zirconia and metal-ceramic restorations, these crowns can be suitable for posterior restoration. Satisfactory investigation is underway to ameliorate the esthetic properties of monolithic zirconia as an appropriate material for anterior teeth (31).

Conclusion

Based on the established findings, although marginal adaptation of monolithic and layered zirconia restorations was proven to be clinically acceptable (less than 120µm), monolithic zirconia crowns demonstrated a superior marginal fit compared to layered zirconia crowns.

Conflict of Interests

The authors declare no conflict of interest.

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References

1. An S, Kim S, Choi H, Lee J-H, Moon H-S. Evaluating the marginal fit of zirconia copings with digital impressions with an intraoral digital scanner. J Prosthet Dent. 2014;112(5):1171-1175.

2. Vojdani M. Comparison the Marginal and Internal Fit of Metal Copings Cast from Wax Patterns Fabricated by CAD/CAM and Conventional Wax up Techniques. J Dent Shiraz Univ Med Sci. 2013;14(3): 118-129.

3. Lee KB, Park CW, Kim KH, Kwon TY. Marginal and internal fit of all-ceramic crowns fabricated with two different CAD/CAM systems. Dent Mater J. 2008;27(3):422-426.

4. Hung SH, Hung KS, Eick JD, Chappell RP. Marginal fit of porcelain-fused-to-metal and two types of ceramic crown. J Prosthet Dent 1990;63(1):26-31

5. Ahmed WM, Abdallah MN, McCullagh AP, Wyatt CC, Troczynski T, Carvalho RM. Marginal discrepancies of monolithic zirconia crowns: the influence of preparation designs and sintering techniques. J Prosthodontics. 2019;28(3):288-98.

6. Hung SH, Hung K-S, Eick JD, Chappell RP. Marginal fit of porcelain-fused-to-metal and two types of ceramic crown. J Prosthet Dent. 1990;63(1):26-31.

7. Jalalian E, Sadegh M, Masoomi S, Jalalian S, Ziyaei AE. Effect of Thickness of Zirconia Core on Marginal Adaptation of All-Ceramic Restorations. J Iran Dent Assoc. 2014;26(3):158-162.

8. Mohammed MI, Mandour MH, Shetawey RA. Marginal and Internal Fit of Monolithic and Veneered Zirconia Crowns. ADJ-for Gril. 2019;6(2):187-194.

9. Guess PC,Zavanelli RA,Silva NR, Bonfante EA, Coelho PG, Thompson VP.Monolithic CAD/CAM lithium disilicate versus veneered Y-TZP crowns: comparision of failure modes and reliability after fatigue. Int J Prosthodont.2010;23(5):434-442.

10. Torabi K, Vojdani M, Giti R, Taghva M, Pardis S. The effect of various veneering techniques on the marginal fit of zirconia copings. J Adv Prosthodont. 2015;7(3):233-239.

11. Gonzalo E, Suarez MJ, Serrano B, Lozano JF. A comparison of the marginal vertical discrepancies of zirconium and metal ceramic posterior fixed dental prostheses before and after cementation. J Prosthet Dent. 2009; 102:378-384

12. Rayyan MR. Marginal adaptation of monolithic high-translucency versus porcelain-veneered zirconia crowns. Int J Prosthodont. 2019; 32:364-366.

13. Papadiochou S,Pissiotis AL .Marginal adaptation and CAD-CAM technology:A systematic review of restorative material and fabrication techniques.J Prosthet Dent .2018;119(4):545-551.

14. Zhang Y. Making yttria-stabilized tetragonal zirconia translucent. Dent Mater. 2014;30(10):1195-1203.

15. Amuthavalli V, Manoharan P, Shivasakthy M. A comparative evaluation of marginal fit of all ceramic crowns fabricated with zirconia cored crowns and monolithic crowns-An in vitro study. J Adv Clin Res Insights. 2020;7(1):1-6.

16. Saraswathi DD, Leneena G, Babu MR, Sudheer V, Puvvada SC, Vyapaka P. Comparative evaluation of marginal vertical discrepancies of full zirconia crowns, layered zirconia crowns, and metal ceramic crowns: An in vitro study. J Int Oral Health. 2016;8(2):208-2013.

17. Mohaghegh M, Firouzmandi M, Ansarifard E, Ramazani L. Marginal fit of full contour monolithic zirconia in different thicknesses and layered zirconia crowns. J Int Oral Health. 2020;10(5):652-658.

18. Felton DA, Kanoy BE, Bayne SC, et al: Effect of in vivo crown margin discrepancies on periodontal health. J Prosthet Dent. 1991;65(3):357-364

19. Gonzalo E, Suárez MJ, Serrano B, Lozano JF. A comparison of the marginal vertical discrepancies of zirconium and metal ceramic posterior fixed dental prostheses before and after cementation. J Prosthet Dent. 2009;102(6):378-384.

20. Rayyan MR. Marginal adaptation of monolithic high-translucency versus porcelain-veneered zirconia crowns. Int J Prosthodont. 2019; 32:364-366.

21. Att W, Komine F, Gerds T, Strub JR. Marginal adaptation of three different zirconium dioxide three-unit fixed dental prostheses. J Prosthet Dent. 2009;101(4):239-247.

22. Weaver JD, Johnson GH, Bales DJ. Marginal adaptation of castable ceramic crowns. J Prosthet Dent. 1991;66(6):747-753.

23. Balkaya MC, Cinar A, Pamuk S. Influence of firing cycles on the margin distortion of 3 all-ceramic crown systems. J Prosthet Dent. 2005;93(4):346-355

24. Komine F, Iwai T, Kobayashi K, Matsumura H. Marginal and internal adaptation of zirconium dioxide ceramic copings and crowns with different finish line designs. Dent Mater J. 2007;26(5):659-664.

25. Al-Assadi HZ, Al-Azzawi AKJ. The effect of porcelain veneering on marginal fitness of zirconia copingscompared to full contour zirconia crown using three different CAD/CAMsystems (An In vitro study).J Genet Environ Resour Conserv. 2015;3(3):205-211.

26. Al-Baadani Ah, Sherief Rm, Kheireldean At. Evaluation Of Internal Adaptation Of Full Contour Zirconia Crowns Versus Veneered Zirconia Crowns–In Vitro Study. Egypt Dent J. 2016;62(3):717-719.

27. Jalalian E, Zarbakhsh A, Mohtashamrad Z, Nourbakhsh N, Jafarpour E. In Vitro Effect of Porcelain Firing Cycle and Different Thicknesses of IPS E. max CAD Core on Marginal Accuracy of All-Ceramic Restorations. J Dent (Tehran). 2015;12(11):815-822.

28. Jalalian E, Bagheri M, Masoumi S. Effect of Core Thickness and Porcelain Sintering on Marginal Adaptation. J Res Dent Maxillofacial. 2018;3(2):1-6.

29. Miura S, Inagaki R, Kasahara S, Yoda M. Fit of zirconia all-ceramic crowns with different cervical margin designs, before and after porcelain firing and glazing. Dent Mater J. 2014;33(4):484-489.

30. Rinke S, Fischer C. Range of indications for translucent zirconia modifications: Quintessence Int.2013;44(8):557-566.

31. Al-Zubaidi Z, Al-Shamma A. The effect of different finishing lines on the marginal fitness of full contour zirconia and glass ceramic CAD/CAM crowns (an in-vitro study). J Dent Mater Tech. 2015;4(3):127-36.

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