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MARGINAL ACCURACY OF MACHINABLE ULTRA TRANSLUCENT ZIRCONIA, RESIN COMPOSITE, AND LITHIUM DISILICATE LAMINATE VENEERS FABRICATED FROM TWO ACQUISITION TECHNIQUES

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ABSTRACT

Aim: to investigate the marginal accuracy of laminate veneers fabricated from machinable ultra-translucent zirconia and resin composite in comparison to lithium disilicate using two different acquisition techniques.

Materials and methods: A typodont's upper right central incisor was prepared with a laminate veneer butt-joint preparation design. 36 laminate veneers were fabricated and divided into 3 groups: **(L):** Lithium disilicate (IPS e.max CAD), **(Z):** Ultra-translucent zirconia (Katana UTML), and **(C):** Resin composite (Brilliant Crios). The groups were further divided into 2 subgroups based on scanning techniques: **(D):** directly scan the typodont utilizing an intra-oral scanner (Medit i500) as well as **(I):** Indirectly scan the cast utilizing a laboratory scanner (in-Eos X5). Exocad software and the 5-axis milling machine were utilized to fabricate the veneers. The marginal accuracy was measured using a stereomicroscope.

Results: A comparison of marginal accuracy for various materials in each scanning group revealed that ultra-translucent zirconia had significantly higher marginal adaptation values than other materials for either the extra-oral or intraoral scanning groups, while no significant difference was found between lithium disilicate and resin composite. No significant difference was observed between the extra-oral and intraoral scanning for each material when comparing the two scanning methods among all the materials.

Conclusion: Ultra-translucent zirconia showed the best marginal accuracy among other groups. No difference in marginal accuracy between lithium disilicate and resin composite. Additionally, Variations in scanning techniques used for the fabrication of different materials showed an insignificant effect regarding the marginal fit.

KEYWORDS: Esthetic materials, Direct scanning, Indirect scanning, Laminate Veneers, Marginal accuracy.

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INTRODUCTION

Laminate veneers are one of the best conservative treatment options for different situations, such as correcting the alignment of minimally crowded teeth, masking discoloration of the tooth surface, closing diastema or spacing between teeth, restoring minimally destructed teeth, and for esthetic purposes. (1)

A wide range of materials is used for the fabrication of laminate veneers. Lithium disilicate is commonly used to fabricate laminate veneers as it has high optical features as well as relatively high mechanical properties. (2) Other materials were discovered, such as ultra-translucent zirconia to be used for laminate veneer fabrication as it has high translucency and can be milled in very thin thicknesses with high resistance to edge chipping. (3) But, due to the brittle nature of ceramics, new esthetic materials have been generated, such as resin composite materials that could be ground into thin thicknesses, which are used for conservative tooth preparation designs with high esthetics, relatively high strength, and superior bonding ability. (4)

In digital dentistry, the digital fabrication of restorations could be done by using different scanning techniques, which include the direct acquisition technique in which an intraoral scanner is used to scan the prepared teeth intraorally, and the indirect acquisition technique in which a laboratory scanner is utilized in the acquisition of conventional impressions or stone casts. (5)(6)

Increased marginal misfit of restorations disintegrates the cement layer by oral fluids, which could lead to periodontal response and secondary caries, as a result, the marginal discrepancy must be as minimal as possible to increase the longevity of the restorations as much as possible. The accepted marginal gap value of the restorations synthesized by CAD/CAM should not exceed 90 μm. (7)(8)

The objective of this study was to measure and compare the marginal accuracy of three different CAD/CAM esthetic materials for fabricating laminate veneers: lithium disilicate, ultra-translucent zirconia, and resin composite, while utilizing two different acquisition techniques.

MATERIALS AND METHODS

Thirty-six laminate veneers were constructed. According to the material, the laminate veneers were divided into three groups (n=12): **Group L:** lithium disilicate (IPS e.max CAD), **Group Z**: ultra-translucent zirconia (Katana UTML), and **Group C:** resin composite (Brilliant Crios). The groups were further divided into two subgroups **(D** and **I)** based on acquisition technique (n=6): $\mathbf{L_D}$, $\mathbf{L_I}$, $\mathbf{Z_D}$, $\mathbf{Z_I}$, $\mathbf{C_D}$, and $\mathbf{C_I}$, while, **subgroup D**: direct scanning using an intraoral scanner (Medit i500) and **subgroup (I):** Indirect scanning using an extra-oral scanner (in-Eos X5)

Acrylic tooth preparation:

A typodont's upper right central incisor (NISSIN Dental Model, Koyota, Japan) was utilized for laminate veneer preparation. A putty index (PANASIL, Kettenbach Dental, Germany) was made to ensure uniform and sufficient tooth reduction. The incisal edge was reduced by 1 mm butt-joint design using size 12 tapered diamond stone with a round end (Frank, Germany). A guided labial preparation was done in two planes, cervically and incisally by 0.3 and 0.5 mm, respectively, using depth cutter stones followed by a size 12 tapered diamond stone with a round end to create a chamfer finish line located 0.5 supraginivally with a thickness of 0.3 mm. The reduction was ended mesially and distally without breaking the contact area. Finishing and polishing were done using yellow and red finishing diamond stones followed by a polishing paste and a polishing brush **[Figure 1]**.

Fig. (1) Laminate veneer preparation with a butt-joint incisal preparation design

Stone model fabrication:

A two-step conventional impression was taken encompassing the reduced tooth as well as the full upper dental arch of the model cast utilizing a putty followed by a light-body PVS material (PANASIL, Kettenbach Dental, Germany) through a stainless steel perforated impression tray. Thirty minutes later, the impression was filled with dental hard stone (TST, Dental hard stone, Taiwan) to obtain the stone model.

Laminate Veneer construction procedure:

Two different acquisition techniques were used which include the direct and indirect scanning procedures. The direct scanning procedure was done by taking a digital impression of the prepared typodont model using an intraoral scanner "Medit i500" (Medit, South Korea). The indirect scanning procedure was done by taking a digital impression of the stone model using an extra-oral scanner "in-Eos X5" (Dentsply Sirona, Germany) **[Figure 2]**. Two designs were created for each scan by copy & mirror feature with a 50 μm cement space using the Exocad ChairsideCAD 2.3 software. A 5-axis milling machine, "InLab MC X5" (Dentsply Sirona, Germany), was utilized for the milling of all the specimens. Milling of each material was done following the manufacturer's instructions, as a result, the milling of lithium disilicate and composite groups was done by wet milling technique using diamond stones sizes 2.2, 1.4, 1.2, and 0.6 respectively, while the milling of the zirconia group was done by dry milling technique using carbide burs sizes 2.5, 1, and 0.5 respectively. After milling of all the veneers, for the IPS e.max CAD (IvoclarVivadent, Schaan, Liechtenstein) veneers, a combined crystallization and glazing process was carried out using Programat CS3 porcelain furcane and IPS e.max CAD Crystal/Glaze Paste (IvoclarVivadent, Schaan, Liechtenstein) for glazing. For the Katana Zirconia UTML (Kurary Nortike Dental Inc., Japan) group, sintering was done in InFire HTC speed furnace (Sirona, Germany) followed by glazing of the restorations in the Programat CS3 furnace using Apply CZR PRESS glaze (Kurary Nortike Dental Inc., Japan). While for the BRILLIANT Crios (Coltène Whaledent Feldwiesenstrasse, Altstätten, Switzerland) group, the restorations were finished

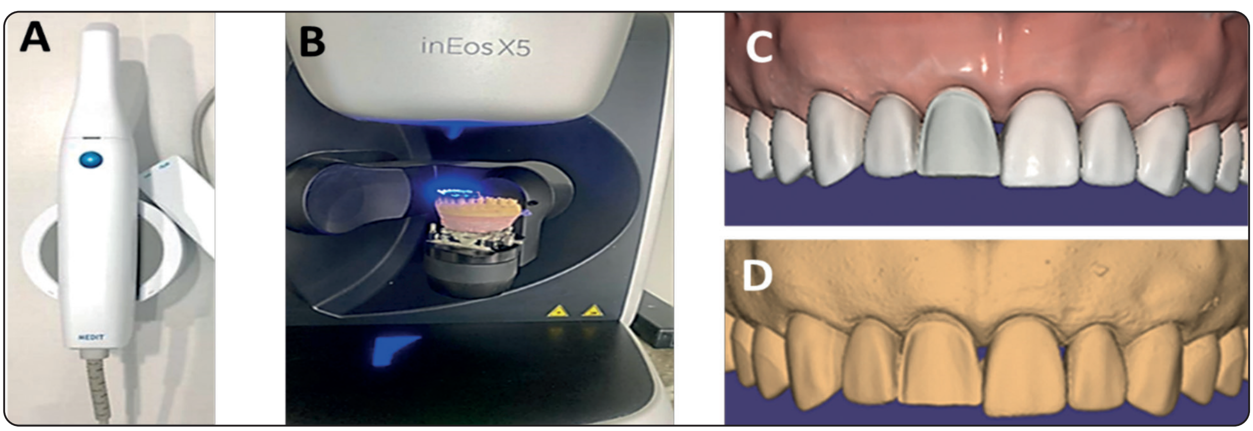

Fig. (2) (A) Medit i500, (B) in-Eos X5, (C&D) Virtual images of the typodont and stone models respectively and polished using the DIATECH diamond polishing system (Coltène Whaledent Feldwiesenstrasse, Altstätten, Switzerland). After the construction of the veneers, all the specimens were verified for seating on the typodont model.

Marginal Accuracy measurements:

The vertical marginal gap was measured for all the veneers using a stereomicroscope "Lecia SAPO" (Leica Microsystems, Bensheim, German) at a fixed magnification of 45X and a digital image analysis system (Image J 1.43U, NIH, USA). To prevent movement of the veneers during their measurements, a single drop of Te-Econom Bonding agent (IvoclarVivadent, Schaan, Liechtenstein) was applied to secure the veneers to the typodont model. The vertical marginal gap was measured for each veneer at three predetermined points on each surface. These selected points were marked using an ultra-thin black permanent marker. For the incisal surface, mesio-incisal, mid-incisal, and disto-incisal points were measured. For the cervical surface, mesio-cervical, mid-cervical, and disto-cervical points were measured. For the mesial surface, inciso-mesial, mid-mesial, and cervico-mesial points were measured. For the distal surface, inciso-distal, mid-distal, and cervico-distal points were measured. Measurements of these 12 points were repeated 3 times for each point **[Figure 3]**. After measurements, the data were statistically analyzed.

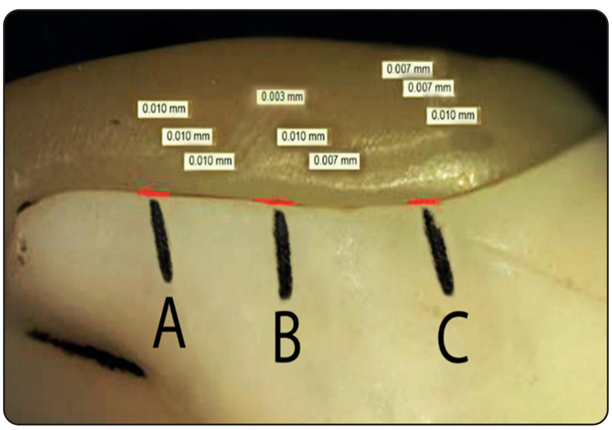

Fig. (3): Measuring of a representative sample under the stereomicroscope

RESULTS

Correlation between different scanning subgroups within each group using paired t-test

1. **Group L:** Non-significant difference was recorded between the $\mathbf{L_I}$ as well as $\mathbf{L_D}$ groups in the cervical, mesial, distal, and incisal surfaces **[Table 1]**
2. **Group Z:** Non-significant difference was recorded between the $\mathbf{Z_I}$ as well as $\mathbf{Z_D}$ in the cervical as well as distal surfaces, while there was a significant difference between $\mathbf{Z_I}$ and $\mathbf{Z_D}$ in the mesial and incisal surfaces **[Table 2].**
3. **Group C:** Non-significant difference was recorded between the $\mathbf{L_I}$ as well as $\mathbf{L_D}$ groups in the cervical, mesial, distal, and incisal surfaces **[Table 3].**

Correlation between different groups in each scanning subgroup:

1. **Indirect Scanning of the three groups:** comparison between the groups **($\mathbf{L_I}$, $\mathbf{Z_I}$, and $\mathbf{C_I}$)** was performed using One Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons **[Table 4]** which revealed that: in the cervical surface, the $\mathbf{Z_I}$ group had significantly lower marginal gap values than the $\mathbf{L_I}$ and $\mathbf{C_I}$ groups, while, no significant difference was recorded between $\mathbf{L_I}$ or $\mathbf{C_I}$ groups. For the mesial and incisal surfaces, no statistically significant difference was recorded between the groups. In the distal surface, the $\mathbf{Z_I}$ group had significantly lower marginal gap values than the $\mathbf{C_I}$ group, while no significant difference was recorded between the $\mathbf{L_I}$ and either $\mathbf{Z_I}$ or $\mathbf{C_I}$ groups.
2. **Direct Scanning of the three groups:** comparison between the groups **($\mathbf{L_D}$, $\mathbf{Z_D}$, and $\mathbf{C_D}$)** was performed using One Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons **[Table 4]** which revealed that: in the

TABLE [1] The Mean and standard deviation (SD) values of the marginal accuracy (μm) of the lithium disilicate group in both indirect and direct scanning subgroups

Lithium disilicate					
Surface	Indirect scanning (L_I)		Direct scanning (L_D)		P-value
	Mean	SD	Mean	SD	
Cervical	15.15[a]	1.22	15.74[a]	2.19	**0.64**
Mesial	13.57[a]	3.44	14.22[a]	1.94	**0.77**
Distal	13.32[a]	1.04	15.06[a]	2.82	**0.07**
Incisal	15.00[a]	1.10	15.04[a]	0.72	**0.78**

Different letters within the same row indicate significant difference, *; significant (p≤ 0.05)

TABLE [2] The Mean and standard deviation (SD) values of the marginal accuracy (μm) of the ultra-translucent zirconia group in both indirect and direct scanning subgroups

Ultra-translucent Zirconia					
Surface	Indirect scanning (Z_I)		Direct scanning (Z_D)		P-value
	Mean	SD	Mean	SD	
Cervical	10.87[a]	0.96	12.78[a]	1.92	**0.13**
Mesial	10.22[b]	1.93	12.91[a]	1.85	**<0.001***
Distal	12.17[a]	0.18	13.76[a]	2.28	**0.14**
Incisal	15.78[a]	2.31	13.76[b]	1.45	**0.02***

Different letters within the same row indicate significant difference, *; significant (p≤ 0.05)

TABLE [3] The Mean and standard deviation (SD) values of the marginal accuracy (μm) of the resin composite group in both indirect and direct scanning subgroups

Resin Composite					
Surface	Indirect scanning (C_I)		Direct scanning (C_D)		P-value
	Mean	SD	Mean	SD	
Cervical	15.83[a]	1.58	15.11[a]	1.24	**0.43**
Mesial	11.15[a]	2.55	11.20[a]	1.58	**0.77**
Distal	15.46[a]	0.18	14.98[a]	2.28	**0.7**
Incisal	16.46[a]	1.1	18.87[a]	3.65	**0.13**

Different letters within the same row indicate significant difference, *; significant (p≤ 0.05)

cervical surface, the $\mathbf{Z_D}$ group had significantly lower marginal gap values than the $\mathbf{L_D}$ group, while, no significant difference was recorded between $\mathbf{C_D}$ and either $\mathbf{Z_D}$ or $\mathbf{L_D}$ groups. In the mesial surface, the $\mathbf{C_D}$ group had significantly lower marginal gap values than the $\mathbf{L_D}$ group. At the same time, no significant difference was recorded between the $\mathbf{Z_D}$ and either $\mathbf{L_D}$ or $\mathbf{C_D}$ groups. No statistically significant difference between the groups on the distal surface. For the incisal surface, the $\mathbf{C_D}$ group had significantly higher marginal gap values than the $\mathbf{Z_D}$ and $\mathbf{L_D}$ groups; additionally, no significant difference was recorded between $\mathbf{Z_D}$ and $\mathbf{L_D}$ groups.

The overall correlation between all groups in both scanning subgroups:

A comparison between the two scanning subgroups in each group was performed using a paired t-test **[Table 5]**, revealing no statistically significant difference between the indirect and direct scanning for the **L, Z,** and **C** groups.

A comparison between all groups in each scanning subgroup was performed using a One-Way ANOVA test followed by Tukey`s Post Hoc test for multiple comparisons **[Table 5]**, which revealed that the **Z** group had significantly lower marginal gap values than the **L** and **C** groups. At the same time, there was no significant difference between the L or C groups in either direct or indirect scanning.

TABLE [4] The Mean and standard deviation (SD) values of the marginal accuracy (μm) of different groups in the indirect and direct scanning subgroup

Scanning	Surface	Lithium disilicate		Ultra-translucent Zirconia		Resin Composite		P-value
		Mean	SD	Mean	SD	Mean	SD	
Indirect scanning	Cervical	15.15[a]	1.22	10.87[b]	0.96	15.83[a]	1.58	**<0.001***
	Mesial	13.57[a]	3.44	10.22[a]	1.93	11.15[a]	2.55	**0.12**
	Distal	13.32[ab]	1.04	12.17[b]	0.18	15.46[a]	2.75	**0.006***
	Incisal	15.00[a]	1.10	15.78[a]	2.31	16.46[a]	1.10	**0.31**
Direct scanning	Cervical	15.74[a]	2.19	12.78[b]	1.92	15.11[ab]	1.24	**0.032***
	Mesial	14.22[a]	1.94	12.91[ab]	1.85	11.2[b]	1.58	**0.037***
	Distal	15.06[a]	2.82	13.76[a]	2.28	14.98[a]	1.35	**0.26**
	Incisal	15.04[b]	0.72	13.76[b]	1.45	18.87[a]	3.65	**0.001***

Different letters within the same row indicate significant difference, *; significant (p≤ 0.05)

TABLE [5] The Mean and standard deviation (SD) values of the marginal accuracy (μm) of different groups and subgroups

Groups	Direct scanning		Indirect scanning		P-value
	Mean	SD	Mean	SD	
Lithium Disilicate	14.26[Aa]	2.02	15.2[Aa]	1.83	**0.16**
Ultra translucent Zirconia	12.26[Ba]	2.64	13.3[Ba]	1.83	**0.06**
Resin Composite	14.75[Aa]	2.87	15.2[Aa]	3.33	**0.5**
P-value	**0.003***		**0.01***		

Different uppercase letters within the same column denote significant differences, different lowercase letters within the same row denote significant differences, *; significant (p≤ 0.05)

DISCUSSION

Ceramic laminate veneers are one of the most conservative treatment options for correcting different esthetic problems, such as minimally crowded teeth, discoloration of the tooth surface, diastema, or spacing between teeth, and for esthetic improvement. [1]

This study investigated three different CAD/CAM esthetic materials: lithium disilicate, ultra-translucent zirconia, and resin composite. Lithium disilicate has been a preferred material for laminate veneers due to its superior optical and mechanical properties. [2] [9] Ultra-translucent zirconia can be used for laminate veneer due to its superior mechanical properties, edge chipping resistance, and increased translucency. [10] Resin composite has been developed to overcome ceramics' brittleness, offering high esthetics, strength, and reduced wear in tooth preparation designs. [4] [11]

This study selected a typodont tooth as a model for laminate veneer restoration to overcome dimensional differences between natural teeth, allowing standardization of samples. [12][13]

The typodont tooth was prepared according to laminate veneer preparation guidelines, mimicking preparation in natural teeth. [14] Sectioned silicone putty index and depth cutters were used for uniform and sufficient tooth reduction. [12]

A vinyl poly-siloxane material was employed to take an impression of the prepared typodont model. Due to extremely low polymerization shrinkage, high dimensional accuracy, good detail reproducibility, and simplicity of use. [15] Type IV stone was used to pour the stone model due to its high precision, hardness, and strength. [16]

Two scans were performed by one operator. One was the direct scan of the prepared typodont model using an intraoral scanner "Medit i500" as it has high trueness and precision, and it does not require powder for scanning, allowing easy file transfer and optimizing operator collaboration. The other was the indirect scan by scanning the stone cast utilizing a laboratory scanner "in-Eos X5," which ensured high accuracy and easy STL file export. Design of the restorations was done utilizing Exocad software with a 50 μm cement space. [17]

The marginal discrepancy significantly influences restoration success, as increased discrepancy can cause oral fluids to disintegrate cement, leading to secondary caries and poor periodontium, hence minimizing restorations longevity. [18] The marginal accuracy was measured using a stereomicroscope as it is an accurate, non-destructive method. [19]

Marginal accuracy measurements were conducted without the samples being cemented to avoid any potential changes after cementation. [20]

The restoration's marginal gap was assessed by measuring each veneer surface at three predetermined points per surface, resulting in twelve measurement points per veneer to ensure relevant results of marginal fit. [21] [22]

Previous studies stated that for the restorations to be accepted clinically, the vertical margin gap should be less than 120 μm. [23-25] While for the restorations synthesized by CAD/CAM, the marginal gap should not exceed 90 μm. [7][8] As the mean marginal gap of each group in the present investigation fell in the clinically accepted range, therefore, it could be assumed that all the tested groups have optimum marginal accuracy.

Based on the results of the present study, the null hypothesis which stated that there would be no significant differences in the marginal accuracy between machinable lithium disilicate, ultra-translucent zirconia, and resin composite laminate veneers, produced through two different scanning techniques: direct and indirect had to be partially rejected as there was a significant difference between different materials. On the other hand, there was no significant difference between intraoral and extra-oral scanning in each material group.

Results of this study revealed that comparison between the different materials in each scanning group showed that the ultra-translucent zirconia group had significantly lower marginal gap values than either the lithium disilicate or resin composite groups, at the same time, no significant difference was recorded between the lithium disilicate or resin composite groups in either the direct or indirect scanning.

Although, the results of this study revealed a statistically significant difference between the groups, but this difference is not clinically significant as the mean marginal gap of each group in the present investigation fell in the clinically accepted range, therefore, it could be assumed that all the tested groups have optimum marginal accuracy.

The findings of this study showed that the ultra-translucent zirconia showed superior marginal adaptation values. This could be attributed to its high mechanical properties and edge chipping resistance [10] as well as the high CAD/CAM system's accuracy during milling zirconia restorations as CAD/CAM systems were initially designed to mill polycrystalline ceramics. [26]

These findings were in accordance with **Ferrini et al., (2023)** [27] who tested the marginal adaptation of crowns fabricated from lithium disilicate, zirconia, and composite. The authors found that the zirconia had a significantly higher marginal fit than other groups.

These results agreed with **Nawafleh et al., (2023)** [28] who investigated the marginal discrepancy of machinable lithium disilicate and zirconia crowns. They found that compared to lithium disilicate, zirconia exhibited a smaller marginal gap.

Also, these findings were in accordance with **de Paula Silveira et al., (2017)** [29] and **Naffah et al., (2019)** [30] who studied the marginal fit of crowns made from lithium disilicate and composite. They found that there was no significant difference between the two groups.

The results were in contrast with **Riccitiello et al., (2018)** [26] who studied the fit of crowns fabricated from lithium disilicate as well as zirconia. They found that the two groups had insignificant differences regarding the marginal accuracy. This might be due to the different marginal gap measurement method as Micro-CT was utilized in their study.

Also, the results of this investigation were inconsistent with **Kapler et al., (2020)** [31] and **Mohammed & Majeed, (2020)** [32], who tested crowns were fabricated from glass ceramics and composite. They concluded that composite had significantly better marginal adaptation than glass ceramics. This may be due to the using of natural teeth as dies which may include differences that could affect the accuracy of marginal assessment.

Comparison between the two scanning methods for each material in the present study showed that there was no statistically significant difference recorded between the indirect and direct scanning for lithium disilicate, ultra-translucent zirconia, and composite groups.

These results were in agreement with **Lee et al., (2018)** [33] who assessed the effect of scanning technique on the marginal gap of zirconia copings. They concluded that there was no significant difference between the intraoral and extra-oral scanning.

Our findings were also following **Freire et al., (2021)** [34] who compared the marginal fit of crowns made from lithium disilicate and zirconia fabricated by different acquisition techniques. It was found that the marginal fit was non-significantly different between the intraoral and laboratory scanning in both materials.

Additionally, the findings of this investigation were consistent with **Al-Dwairi et al., (2023)** [35] who investigated the influence of both direct and indirect scanning on the marginal accuracy of laminate veneers made from e.max CAD. They found that there was no significant difference between the two groups.

Whereas, the findings were in disagreement with **Pedroche et al., (2016)** [36] who compared the marginal accuracy of zirconia copings constructed by different scanning methods, the results of their study revealed that the indirect scanning showed a significantly higher marginal gap than the direct scanning. This might be attributed to the different margin measuring method which was the replica technique, as well as the use of different scanners.

Moreover, the results did not coincide with those of **Asaad, (2019)** [37] who tested the effect of scanning on the marginal fit of crowns made from zirconia and resin ceramics. The author concluded that intraoral scanning had a significantly higher marginal fit than extra-oral scanning in the two materials. This difference may be related to that they scanned premolars, which are more difficult and less accurate in scanning than anterior teeth, Also, they made the study on crowns, not laminate veneers.

These findings were also in contrast with **Lee et al., (2020)** [38] who studied the effect of scanning methods on the marginal accuracy of lithium disilicate crowns. They concluded that crowns made using the intraoral scanning method have a significantly higher marginal fit than those fabricated using extra-oral scanners. This difference may be due to the different marginal fit measuring technique which was the replica technique.

To summarize the results of the study, all the groups have clinically accepted marginal accuracy. In comparison between the different materials in each scanning group, the results showed that the ultra-translucent zirconia group had significantly lower marginal gap values than either the lithium disilicate or resin composite groups, at the same time, no significant difference was recorded between the lithium disilicate or resin composite groups in either the direct or indirect scanning. While, comparison between the two scanning methods for each material in the present study showed that there was no statistically significant difference recorded between the indirect and direct scanning for lithium disilicate, ultra-translucent zirconia, and composite groups.

Considering the limitations of this study, this in vitro study needs further investigations using natural teeth and cementation of the restorations to the corresponding teeth.

CONCLUSION

1. All groups' marginal accuracy had been in the clinically accepted range.
2. Veneers fabricated from ultra-translucent zirconia exhibited the best marginal accuracy with a significant difference among other materials.
3. Lithium-disilicate as well as resin composite showed non-significant differences regarding marginal accuracy.
4. Variations in scanning techniques used for the fabrication of different materials showed an insignificant effect on the marginal accuracy.

RECOMMENDATION

1. Further studies involving natural teeth as substrates and cementation of laminate veneers are recommended. However, an adequate sample size should be considered to overcome the inherent variability involved with natural teeth.
2. More future studies regarding other properties of Katana Zirconia UTML and BRILLIANT Crios, e.g., translucency, color stability, etc., are expected for a better understanding of the materials, especially for long-term usage. Also, to assure its suitability for clinical use.
3. Further investigations regarding other properties of laminate veneers fabricated from different scanning techniques, such as edge stability, are recommended.
4. Composite can safely substitute lithium disilicate in the fabrication of laminate veneers.

REFERENCES

1. Peumans M., D.M.J.F.S.L.P.V.G.V.M.B.(2004). A prospective ten-year clinical trial of porcelain veneers. Journal of Adhesive Dentistry, 6(1), 65–76.

2. Willard, A., & Gabriel Chu, T. M. (2018). The science and application of IPS e.Max dental ceramic. In Kaohsiung Journal of Medical Sciences (Vol. 34, Issue 4, pp. 238–242).

3. Alqutaibi, A. Y., Ghulam, O., Krsoum, M., Binmahmoud, S., Taher, H., Elmalky, W., & Zafar, M. S. (2022). Revolution of Current Dental Zirconia: A Comprehensive Review. MDPI, Molecules, 27(5), 1699.

4. Tsitrou, E. A., Helvatjoglu-Antoniades, M., & van Noort, R. (2010). A preliminary evaluation of the structural integrity and fracture mode of minimally prepared resin-bonded CAD/CAM crowns. Journal of dentistry, 38(1), 16-225.

5. Shimizu, S., Shinya, A., Kuroda, S., & Gomi, H. (2017). The accuracy of the CAD system using intraoral and extraoral scanners for designing of fixed dental prostheses. Dental Materials Journal, 36(4), 402–407.

6. Sason, G., Mistry, G., Tabassum, R., & Shetty, O. (2018). A comparative evaluation of intraoral and extraoral digital impressions: An in vivo study. Journal of Indian Prosthodontist Society, 18(2), 108–116.

7. Abdel-Azim, T., Rogers, K., Elathamna, E., Zandinejad, A., Metz, M., & Morton, D. (2015). Comparison of the marginal fit of lithium disilicate crowns fabricated with CAD/CAM technology by using conventional impressions and two intraoral digital scanners. Journal of Prosthetic Dentistry, 114(4), 554–559.

8. Son K, Lee K-B. (2021). Marginal and Internal Fit of Ceramic Prostheses Fabricated from Different Chairside CAD/CAM Systems: An In Vitro Study. *Applied Sciences*, 11(2), 857.

9. Zarone, F., Di Mauro, M. I., Ausiello, P., Ruggiero, G., & Sorrentino, R. (2019). Current status on lithium disilicate and zirconia: a narrative review. BMC oral health, 19(1), 134.

10. Spitznagel, F. A., Boldt, J., & Gierthmuehlen, P. C. (2018). CAD/CAM Ceramic Restorative Materials for Natural Teeth. Journal of Dental Research, 97(10), 1082–1091.

11. Neshandar M., Eskandarion S., & Rokhshad R. (2021). Classifications and Properties of Materials for Chairside Computer-Aided Design/Computer-Aided Manufacturing Dentistry: A Review. Journal of Research in Dental and Maxillofacial Sciences, 6(2), 36–50.

12. Aboushelib, M., Elmahy, W., & Ghazy, M. (2012). Internal adaptation, marginal accuracy and microleakage of a pressable versus a machinable ceramic laminate veneers. Journal of Dentistry, 40(8), 670–677.

13. Najim, B. A. E.-S., & Al-Rawi, I. I. (2015). The Influence of Different Fabrication Techniques and Preparation Designs on the Marginal Adaptation of Ceramic Veneers : An in Vitro Comparative Study. Journal of Baghdad College of Dentistry, 27(4), 8–14.

14. Farias-Neto A, de Medeiros FCD, Vilanova L, Simonetti Chaves M, Freire Batista de Araújo JJ. (2019). Tooth preparation for ceramic veneers: when less is more. International Journal of Esthetic Dentistry, 14(2):156-164.

15. Khan, S., Tushar, Nezam, S., Singh, P., Kumari, N., & Singh, S. (2020). Comparison and evaluation of linear dimensional accuracy of three elastomeric impression materials at different time intervals using vision inspection system: An in vitro study. Journal of International Society of Preventive and Community Dentistry, 10(6), 736–742.

16. Akkus, B., Demir, N., Karci, M., & Yazman, S. (2018). Compressive and diametral tensile strength of dental stones with SiO2 and Al_2O_3 nanoparticles. Int J Med Sci Innov Res, 3(5), 139-147.

17. Saker, S., & Ozcan, M. (2021). Marginal discrepancy and load to fracture of monolithic zirconia laminate veneers: The effect of preparation design and sintering protocol. Dental Materials Journal, 40(2), 331–338

18. Rizonaki, M., Jacquet, W., Bottenberg, P., Depla, L., Boone, M., & De Coster, P. J. (2022). Evaluation of marginal and internal fit of lithium disilicate CAD-CAM crowns with different finish lines by using a micro-CT technique. Journal of Prosthetic Dentistry, 127(6), 890–898.

19. Demir, N., Ozturk, A. N., & Malkoc, M. A. (2014). Evaluation of the marginal fit of full ceramic crowns by the microcomputed tomography (micro-CT) technique. European Journal of Dentistry, 8(4), 437–444.

20. Yeo, I. S., Yang, J. H., & Lee, J. B. (2003). In vitro marginal fit of three all-ceramic crown systems. The Journal of prosthetic dentistry, 90(5), 459–464.

21. Yüksel, E., & Zaimoğlu, A. (2011). Influence of marginal fit and cement types on microleakage of all-ceramic crown systems. Brazilian oral research, 25(3), 261–266.

22. Guess, P. C., Vagkopoulou, T., Zhang, Y., Wolkewitz, M., & Strub, J. R. (2014). Marginal and internal fit of heat pressed versus CAD/CAM fabricated all-ceramic onlays after exposure to thermo-mechanical fatigue. Journal of Dentistry, 42(2), 199–209.

23. Borba, M., Miranda, W. G., Cesar, P. F., Griggs, J. A., & Bona, Á. Della. (2013). Evaluation of the adaptation of zirconia-based fixed partial dentures using micro-CT technology. Brazilian Oral Research, 27(5), 396–402.

24. Al-Shamma, A. (2015). 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. 4(3): 127-36.

25. Majeed, M. A., & Al-Adel, S. K. (2016). Evaluation of the marginal and internal fitness of full contour CAD/CAM crowns made from zirconia, lithium disilicate, zirconia-reinforced lithium silicate and hybrid dental ceramic by silicone replica technique (A comparative In vitro study). Journal of Genec and Environmental Resources Conservation, 4 (1), 10–20.

26. Riccitiello, F., Amato, M., Leone, R., Spagnuolo, G., & Sorrentino, R. (2018). In vitro Evaluation of the Marginal Fit and Internal Adaptation of Zirconia and Lithium Disilicate Single Crowns: Micro-CT Comparison between Different Manufacturing Procedures. The Open Dentistry Journal, 12(1), 160–172.

27. Ferrini F, Paolone G, Di Domenico GL, Pagani N, Gherlone EF. (2023).SEM Evaluation of the Marginal Accuracy of Zirconia, Lithium Disilicate, and Composite Single Crowns Created by CAD/CAM Method: Comparative Analysis of Different Materials. Materials, 16(6), 2413.

28. Nawafleh, N., Hatamleh, M., Janzeer, Y., Alrahlah, A., & Alahadal, K. (2023). Marginal Discrepancy of Five Contemporary Dental Ceramics for Anterior Restorations. European Journal of Dentistry, 17(4), 1114–1119.

29. de Paula Silveira, A. C., Chaves, S. B., Hilgert, L. A., & Ribeiro, A. P. D. (2017). Marginal and internal fit of CAD-CAM-fabricated composite resin and ceramic crowns scanned by 2 intraoral cameras. Journal of Prosthetic Dentistry, 117(3), 386–392.

30. Naffah, N., Ounsi, H., Ozcan, M., Bassal, H., & Salameh, Z. (2019). Evaluation of the adaptation and fracture resistance of three CAD-CAM resin ceramics: An in vitro study. Journal of Contemporary Dental Practice, 20(5), 571–576.

31. Kapler, R., Oliveira, M. V., de Oliveira Bandeira, I., Metzker, T. C., Carvalho, A. O., & Lima, E. M. C. X. (2020). Analysis of the marginal adaptation of different crowns fabricated with computer-aided technology using an intraoral digital scanner. Brazilian Journal of Oral Sciences, 19, e200537-e200537.

32. Mohammed, Z. H., & Majeed, M. A. (2020). Effect of cementation protocol on the marginal adaptation of indirect overlay restorations fabricated from two different all-ceramic CAD/CAM materials. Journal of Research in Medical and Dental Science, 8(7), 518-525.

33. Lee, B., Oh, K. C., Haam, D., Lee, J. H., & Moon, H. S. (2018). Evaluation of the fit of zirconia copings fabricated by direct and indirect digital scanning procedures. Journal of Prosthetic Dentistry, 120(2), 225–231.

34. Freire, Y., Gonzalo, E., Lopez-Suarez, C., Pelaez, J., & Suarez, M. J. (2021). Evaluation of the marginal fit of monolithic crowns fabricated by direct and indirect digitization. Journal of Prosthodontic Research, 65(3), 291–297.

35. Al-Dwairi, Z. N., Al-Sardi, M., Goodacre, B. J., Goodacre, C. J., Al Hamad, K. Q., Özcan, M., Al-Haj Husain, N., & Baba, N. Z. (2023). Evaluation of Marginal and Internal Fit of Ceramic Laminate Veneers Fabricated with Five Intraoral Scanners and Indirect Digitization. PMCID, Materials, 16(6), 2181.

36. Pedroche, L. O., Bernardes, S. R., Leao, M. P., Kintopp, C. C. D. A., Correr, G. M., Ornaghi, B. P., & Gonzaga, C. C. (2016). Marginal And Internal Fit Of Zirconia Copings Obtained Using Different Digital Scanning Methods. Brazilian Oral Research, 30(1), 1–7.

37. Asaad, R. (2019). Marginal Accuracy of CAD/CAM Fabricated Monolithic All-Ceramic Crowns as a function of Digital Scanning Techniques. Egyptian Dental Journal, 65(2), 1925–1938.

38. Lee, J. H., Son, K., & Lee, K. B. (2020). Marginal and internal fit of ceramic restorations fabricated using digital scanning and conventional impressions: A clinical study. Journal of Clinical Medicine, 9(12), 1–11.